A WATER AND LAND RESOURCE PLAN FOR THE KALAMAZOO-BLACK-MACATAWA -PAW PAW RIVERS BASIN

MAY 1977

CITIZEN'S ADVISORY COUNCIL

COUNTY TASK FORCES

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

U.S. DEPARTMENT OF AGRICULTURE

ADDENDUM

A 6 1/8 percent interest rate was used to develop annual costs for the Kalamazoo River Basin Report. This addendum will show the effects of a 6 3/8 percent interest rate on the costs displayed in the National Economic Development and Regional Development Accounts of each plan. Displays will include the total beneficial effects, total adverse effects, and net beneficial effects of each plan.

SUMMARY NATIONAL ECONOMIC DEVELOPMENT PLAN

National Economic Development Account	
Total beneficial effects	$1,473,000
Total adverse effects	1,102,880
Net beneficial effects	370,120
Regional Development Account	
Total beneficial effects	$1,473,000
Total adverse effects	994,890
Net beneficial effects	478,110

SUMMARY ENVIRONMENTAL QUALITY PLAN

National Economic Development Account	
Total beneficial effects	$121,400
Total adverse effects	295,300
Net beneficial effects	173,900
Regional Development Account	
Total beneficial effects	$121,400
Total adverse effects	101,500
Net beneficial effects	19,900

SUMMARY PREFERRED PLAN

National Economic Development Account	
Total beneficial effects	$898,400
Total adverse effects	833,660
Net beneficial effects	64,740
Regional Development Account	
Total beneficial effects	$898,400
Total adverse effects	604,810
Net beneficial effects	293,590

A WATER AND LAND RESOURCE PLAN

For The

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN

Prepared By:

Citizens Advisory Council
County Task Forces

United States Department of Agriculture
Economic Research Service
Forest Service
Soil Conservation Service

Michigan Department of Natural Resources
Bureau of Environmental Protection
Bureau of Land and Water Management
Bureau of Renewable Resource Management

May 1977

Kalamazoo-Black-Macatawa-Paw Paw River Basin Citizens Advisory Council

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To All Users of This Document:

This document is designed for use of policymakers and citizen conservation leaders who want to breathe reality into the plans developed from the three-year Basin Study. All of us are interested in preserving the resources of the Kalamazoo-Black-Macatawa-Paw Paw River Basin. Certain resources in the Basin are irreplaceable. Many rich natural resources such as prime agricultural lands are being subverted for other uses. Critical wetlands are being filled and drained. Many animals are being driven from natural habitats and will never again appear in certain areas.

For our immediate families and for posterity, we should preserve as well as develop this area.

We are the fortunate recipients of a three-year Study of our natural resources which provides us with an excellent base upon which to continue and to expand our conservation measures. At the same time, this knowledge will permit us to develop the renewable natural resources in the Basin by logical and reasonable means.

The report is wide ranging in its considerations. Water quality, wetlands, forests, agricultural lands, and recreational areas are just a few of the concerns in the Study by the U.S. Department of Agriculture and Michigan Department of Natural Resources.

Such a broad base will permit us an excellent springboard from which to continue the work of creating a more desirable environment for the Kalamazoo-Black-Macatawa-Paw Paw River Basin.

As the report passes into our hands, we must also accept responsibility for implementation. As we thank Mr. Ronald C. Page, Study Director, and his capable staff, we now turn to local public officials and other citizen leaders to assist us in implementing the report.

We need the help of citizens of all ages, and from all walks of life, and especially we need the support of conservation and civic groups who continually provide assistance on projects such as this one.

There are 12 to 14 different categories in which work must be done. It is our aim to search each county for organizations, groups and individuals who are willing to come to the assistance of the Basin and help us to provide for its future.

Robert W. Kaufman
Chairman

Preface

The use of water and land resources in upstream areas of the Basin may have a detrimental effect on the quality of the water in the downstream areas. That is to say, sediment chemicals and nutrients entering the streams in Barry, Calhoun, Eaton, Jackson, and Kalamazoo Counties do not stop at the county lines, but are carried downstream. For this reason the study area is defined by the river basin boundaries rather than by political lines.

This report offers a plan to alleviate some of the conditions that are degrading the water and land resources. A variety of measures are presented to protect, enhance, and more fully utilize these resources. Recognizing that action will be initiated and implemented by individual counties, the results of the study are presented for each county, as well as for the Basin.

To maintain a well defined continuity throughout the report, inventory data and narrative on study procedures not directly relevant to the development of the plan are published in the appendices or as USDA Technical Papers. The report is organized to allow the reader to follow the step by step development of each plan element from a specific study objective. Each chapter describes a separate step in the development of the plan:

Chapter III	-	Study objectives are established which correspond to the water and related land resource problems.
Chapter IV	-	Study objectives are quantified to establish the desired amount of resource development, protection, and enhancement by 1990 and 2020.
Chapter V	-	Overview of the resource conditions in the Basin as they now exist is presented.
Chapter VI	-	Estimates are made of the amount of resource development, protection, and enhancement that will occur by 1990 and 2020, without the assistance of this plan.

Chapter VII - This chapter lists the improvements that are needed to achieve the desired conditions described in Chapter IV. This represents the difference between Chapter IV and VI.

Chapter VIII - Alternative plans stressing economic development and environmental quality are presented.

Chapter IX - The Preferred Plan is presented. This is aggregation of the county plans recommended by the County Task Forces.

Chapter X - Ways to carry out the preferred plan are discussed.

Chapter XI - This is an estimate on what can be accomplished through the USDA Programs.

Acknowledgments

Numerous people, organizations, and governmental officials have taken much of their time to assist in the preparation of this plan. USDA and the Michigan Department of Natural Resources wish to acknowledge their time and thank them for their assistance. Special thanks are in order for the Citizen's Advisory Council for the Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin and the County Task Force organizations who have provided invaluable inputs into the data gathering process. The Technical Committee efforts, consisting of preparation of an Interim Report and review of many documents is also acknowledged and greatly appreciated.

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CHAPTER I

Summary

CHAPTER I

SUMMARY

The Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin Study is a cooperative Federal, State, and local study. Study participants consist of: USDA agencies--Soil Conservation Service, Economic Research Service, and Forest Service; Michigan Department of Natural Resources; Citizens Advisory Council; and 10 County Task Forces.

From the outset both the State and the citizen's groups indicated that the main objective of the Study should be to protect and enhance the environment. It was recognized that the environment was relatively good, but that steps should be taken to avoid future problems and to improve it if possible. Economic development was of secondary importance.

BASIN DESCRIPTION

The Basin consists of four major hydrologic areas: Kalamazoo River Basin--2,020 square miles; Paw Paw River Basin--445 square miles; Black River Basin--295 square miles; and the Macatawa River Basin--172 square miles. These plus the drainage areas of the small streams that drain into Lake Michigan comprise the 3,002 square mile study area referred to in this report as the Basin. The Basin contains parts of 11 counties.

A desire to protect the environment of the Basin is well founded since the area is rich in water and land resources. Nearly 400 miles of top quality streams flow through the Basin, supporting both warmwater and coldwater game fish. Some of the best cropland in the state is located here. Prime orchard and vineyard land is located along Lake Michigan. Forest land, grassland, and wetland together with cropland provide good habitat for a variety of wildlife species.

PROBLEMS

This Study does not identify all the problems related to the water and land resources. It does, however, address most of the problems

identified in the rural, upstream watershed areas. The principal problems examined in this report ...

1. A serious erosion problem on approximately 166,000 acres of cropland concentrated in nine areas. The average erosion rate on these acres is seven tons per acre per year.

2. Agricultural flooding and drainage problems in four locations, affecting over 3,000 acres of cropland. This problem is not widespread, however.

3. Inadequate supply of suitable streambank boat launching locations. There are only six managed stream access sites on the over 1,200 miles of streams in the Basin.

4. Inadequate supply of hunting lands. There are only 56,400 acres of public hunting land, and only 25 percent of the private land is open to hunting.

5. Lack of managed recreation trails to accommodate the growing interest in hiking, bird watching, horseback riding, and cross-county skiing.

6. Urban flooding problems. Areas in Lakewood, Kalamazoo County, and around Paw Paw Lake, Berrien County, experience serious flood damages.

7. Many sources of pollution to the rivers and streams. This Study examined two--sedimentation and livestock waste.

8. Streambank erosion problem on 430 miles of streams. This is especially damaging to fish habitat since all the eroded material enters the streams.

9. Deterioration and destruction of valuable wetlands. This threatens 121,800 acres of wetlands five acres or more in size.

10. Poor quality of upland wildlife habitat.

11. Urban development and misuse of stream corridors. Approximately 374 miles of natural and scenic streams are threatened.

12. Loss of prime agricultural land. Most of the 175,100 acres of prime land is under some degree of development pressure.

13. Poor condition, slow growth, and poor vigor of Basin forests, and the dwindling supplies of sawtimber for forest industries in and around the Basin.

THE PLAN

In accordance with the U.S. Water Resources Council *Principles and Standards for Planning Water and Related Land Resources* two plans were developed that address the problems outlined above. These two plans provided a range of resource management measures, since one plan emphasized economic development while the other emphasized environmental enhancement and protection.

Each County Task Force assembled a composite plan that would be acceptable to the people in the county and that could be implemented by 1990. The plans primarily reflect the people's concern for their environment.

Elements in the county plans were then combined into the Basin Preferred Plan for this report. This plan will result in the following accomplishments when implemented:

1. Reduce erosion on 116,000 acres of cropland.
2. Reduce flooding damages and poor drainage on 2,750 acres of cropland.
3. Provide public access to 285 miles of stream by installing 57 public access sites.
4. Provide public hunting opportunities on 122,000 acres of private land.
5. Provide 105 miles of non-motorized recreational trails. trails.
6. Protect urban property at Lakewood (on Davis Creek) and around Paw Paw Lake from flooding.
7. Accelerate the treatment of livestock waste on 181 farms.
8. Reduce streambank erosion and sedimentation on 330 miles of stream.
9. Protect 65,200 acres of wetland and enhance 43,000 acres of wetland habitat for waterfowl nesting.
10. Improve upland wildlife habitat on 157,700 acres.

11. Protect the natural and scenic values along 291 miles of stream corridors.

12. Protect 157,400 acres of prime agricultural land.

13. Manage and enhance an additional 66,100 acres of forest land.

IMPLEMENTATION

The Citizens Advisory Council should act as the overall sponsor of the Plan. Although having only the power of persuasion, this body can explain the various elements of the Plan and the ways in which it will benefit the entire Basin. The Council can assist in applying for funding of projects and act to coordinate work involving more than one county.

The County Task Forces should act as the primary sponsors of the county plans. They should enlist the support of conservation groups and service clubs, as well as local units of government, and the Soil Conservation Districts to implement individual elements in the county plans.

CHAPTER II

Introduction

CHAPTER II

INTRODUCTION

The Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin is undergoing profound changes in land use. These changes relate to increasing land utilization for highways, utilities, industrial, commercial and residential developments, recreation areas, and intensive agricultural activity. As a result, erosion and sedimentation in streams and lakes, improper uses of land, and deterioration of fish habitat and wildlife habitat and environmental quality in general have occurred and are increasing at a rapid rate. Therefore, it was imperative that an orderly plan of action be developed and implemented by local and State agencies to correct the problems identified.

This Study was initiated at the request of Governor William G. Milliken and the local soil and water conservation districts within the Basin area. The Water Management Bureau of the Michigan Department of Natural Resources, acting for the Governor, carried out a series of meetings to determine interest in a Federal, State and local cooperative study. Interest was expressed by local units of government as well as private individuals.

AUTHORITY FOR STUDY

As a result of the interest on the part of the State and local governments, the U.S. Department of Agriculture authorized a cooperative Study to proceed on September 7, 1972. This authorization is based on Section 6 of the Public Law 83-566, the Watershed Protection and Flood Prevention Act, as amended. The Governor of Michigan designated the Water Resources Commission, Department of Natural Resources to represent the State in carrying out its part of the Study.

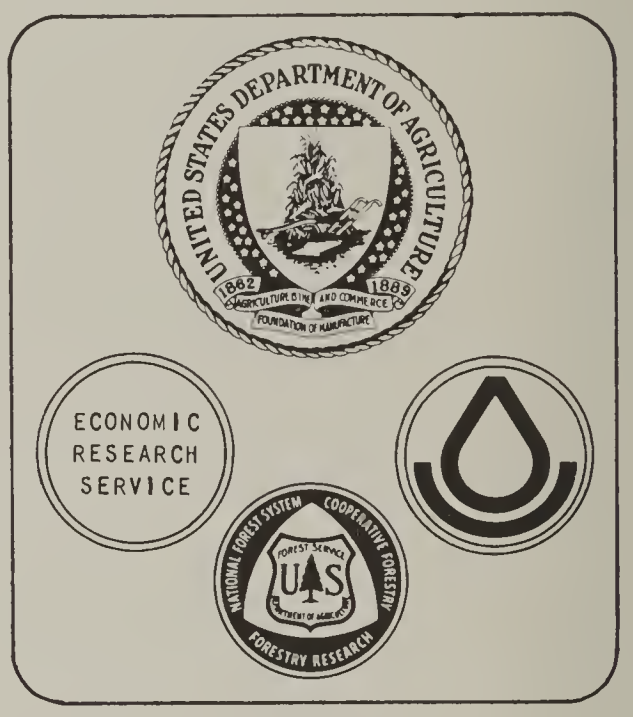
STUDY PARTICIPANTS

This was a cooperative Federal, State, and local study. Citizen groups were involved in all phases of the Study. Study participants

consisted of: USDA agencies--Soil Conservation Service, Economic Research Service and Forest Service; Michigan Department of Natural Resources; Citizens Advisory Council, and ten County Task Forces.

Participation by the U.S. Department of Agriculture was in accordance with a Memorandum of Understanding among the Economic Research Service, Forest Service, and Soil Conservation Service, dated February 2, 1956, and revised April 15, 1968.

The Study was carried out under the general guidance of U.S. Department of Agriculture Field Advisory Committee, composed of a representative from the Soil Conservation Service, the Economic Research Service, and the Forest Service. The Soil Conservation Service provided leadership in carrying out the U.S. Department of Agriculture responsibilities in the Study. Personnel assigned to the Study by the three agencies functioned as a team under the guidance of the Field Advisory Committee. Each agency had responsibility for certain aspects of the Study as outlined in a plan of work approved by the Committee.



OBJECTIVES OF THE STUDY

The overall objective of this Study was to assemble a water and land resource plan that reflected the concerns of the people in the Basin. To help accomplish this, Citizens Advisory Council and the County Task Forces listed their concerns in the initial phase of the Study. These lists showed a strong desire to protect and improve the environment and to encourage a limited amount of resource development. The following specific objectives were identified:

1. Increase production efficiency of food and fiber.
2. Increase available recreational opportunities.
3. Protect existing urban property from flooding.
4. Enhance water quality particularly with respect to recreation, fish and wildlife aspects.
5. Protect and manage areas of natural beauty that provide human enjoyment.
6. Enhance fish and wildlife populations by habitat preservation and improvement.
7. Protect especially valuable or outstanding ecological, archeological, and historical resources.

DESCRIPTION OF THE STUDY AREA

The Basin encompasses a 3,002 square mile area (1,921,463 acres) containing portions of 10 counties in the southwestern corner of Michigan (Figure 2-1). The hydrologic Basin itself includes parts of 11 counties, but because Kent County constitutes only 1.3 percent of the Basin area, with 7,168 acres draining into the Rabbit River, it was not included in the Study. The principal rivers are the Kalamazoo, Macatawa, Black, and Paw Paw, all of which drain into Lake Michigan between Holland and Benton Harbor. Major tributaries of the Kalamazoo include the Rabbit River, Battle Creek, and Portage Creek. The area is about 100 miles long and almost 50 miles wide at its maximum. Topography of the Basin varies from moderately rolling to nearly level. Soils are varied and complex, ranging from very heavy textured clays to sands and gravels to some depressional areas of organic soils. The middle part of the Basin contains a number of natural lakes, which along with Lake Michigan provide numerous recreational opportunities. Climate varies from modified marine (Great Lakes influence) to continental.

In 1970 the Basin had an estimated population of 556,000, a 10 percent increase over that of 1960 and 38 percent above the 1950 population of 403,000. While the rate of growth is slower than that of the state, its urban population has been growing more rapidly--56 percent between 1950 and 1970 versus only a 46 percent increase for the state. Although the population has been shifting from rural to urban, the Basin is still characterized by a large rural population. In 1970, 44 percent was classified as rural in comparison to 26 percent of the state population. Between 1970 and 1990 the Basin's population is expected to increase 20 percent to 665,000 persons; by 2020, population will reach some 780,000 persons.

Of the 3,002 square miles in the Basin, 57 percent (1,093,000 acres) is in cropland and pasture. Forest land is the next largest land cover category, consisting of approximately 405,000 acres. The remainder of the Basin consists of urban areas, brushland, wetland, water, and miscellaneous areas.

Agricultural enterprises within the Basin vary from general farming to production of specialty crops, such as grapes, apples and blueberries. Manufactured products include food, paper, and metal products in addition to wood specialities, drugs, and wine.

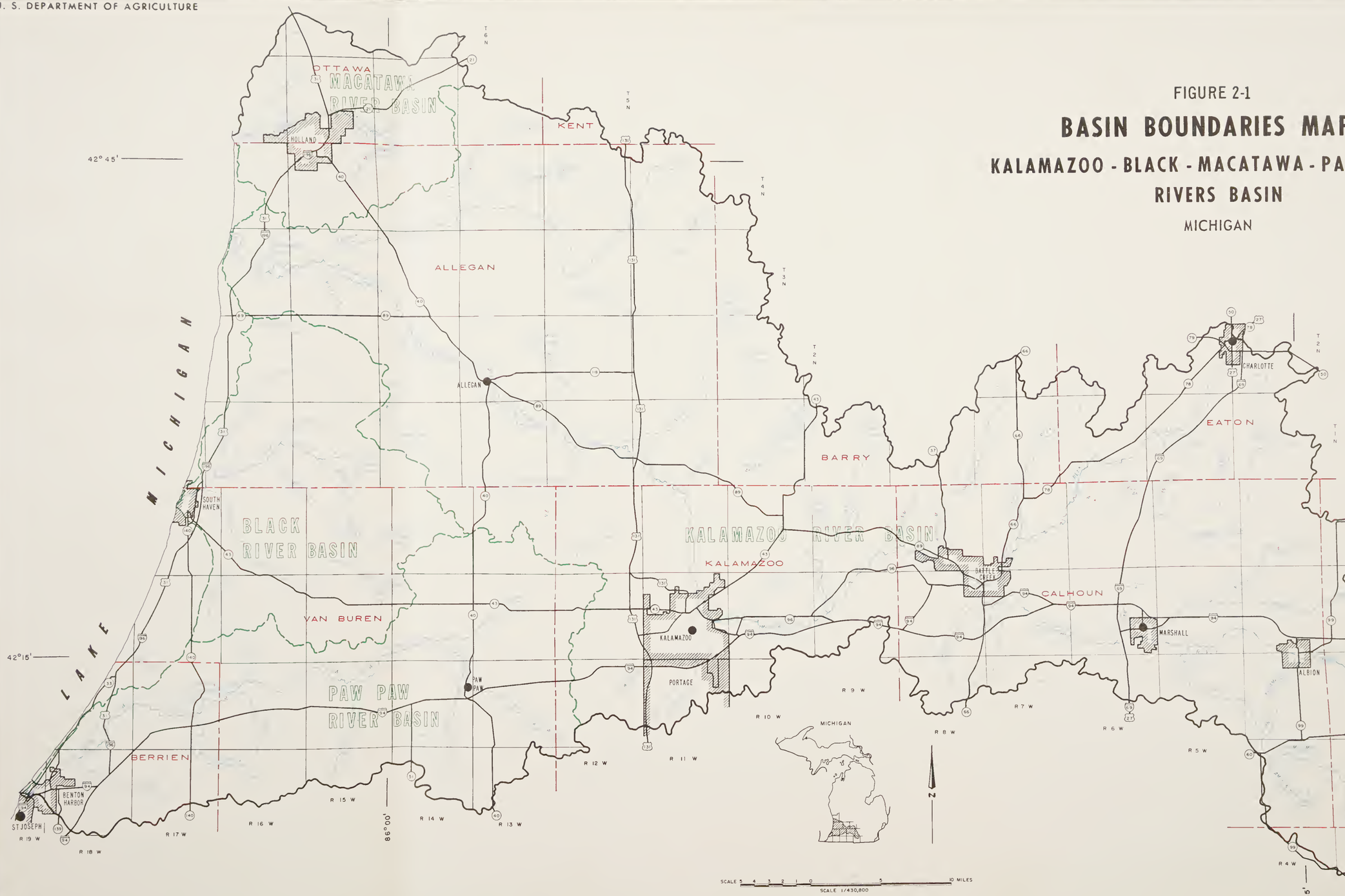
U. S. DEPARTMENT OF AGRICULTURE

FIGURE 2-1

BASIN BOUNDARIES MAP

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN



SOURCE:
FAMILY OF MAPS SCS DRWG NO.5,R-31,085 (1-75)
AND INFORMATION FROM FIELD TECHNICIANS.
TRANSVERSE MERCATOR PROJECTION
USDA - SCS - LINCOLN, NEBR. 1976

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CHAPTER III

Problems and Objectives

CHAPTER III

PROBLEMS AND OBJECTIVES

A wide range of problems were identified by the various County Task Forces and the Citizens Advisory Council. Many of these problems led to the request for the Study and were used to establish the Study objectives. They include:

1. Soil Erosion
2. Water Pollution
3. Flooding
4. Loss of Prime Agricultural Cropland
5. Loss of Fish and Wildlife Habitat
6. Loss of Natural and Scenic Streams
7. Lack of Recreation Opportunities
8. Poor Environmental Conditions on Forest Lands
9. Shortage of Hardwood Sawtimber

Study objectives set forth which problems will be treated in the Plan that evolves from the Study. The identity of each Study objective is maintained throughout the report so that the various planning formulation steps can be followed from chapter to chapter. Each Study objective is related in the Plan to a plan element.

PROBLEMS

SOIL EROSION

Almost 2.5 million tons of soil erode annually from agricultural and forest land in the Basin. An additional 173,000 tons erode on land undergoing urban development. Soil also erodes from streambanks and roadsides. Erosion reduces the capability of the land to produce crops and contributes to water quality problems through sedimentation.

CROPLAND

Most erosion in the Basin occurs on sloping cropland where conventional tillage operations are practiced (Table 3-1). Minimum tillage methods, which limit the number of preplanting and planting operations and put greater reliance on herbicides and less reliance on mechanical cultivation to control weeds, results in significantly lower erosion levels. It is estimated that only 25 percent of the Basin's cultivated cropland is now farmed with minimum tillage methods whereas 75 percent is conventionally tilled. Other land uses--open and idle cropland, specialty crops, pasture, and forest account for a small portion of total gross erosion.

TABLE 3-1--EROSION RATES ON AGRICULTURAL AND FOREST LAND

	Acres	Average Erosion/Year Tons/Acre	Total Tons
General Cropland			
Conventional Tillage	336,400	5.0	1,682,000
Minimum Tillage	115,600	3.5	404,600
No Tillage	3,900	0.5	2,000
	455,900	4.6	2,088,600
Idle Cropland	275,100	0.1	27,500
Specialty Cropland	274,800	0.6	164,900
Total Cropland	1,005,800	2.3	2,281,000
Pasture	87,200	0.3	26,200
Forest	404,900	0.4	162,000
TOTAL	1,497,900	1.6	2,469,200

Of the 1,005,800 acres of cropland in the Basin, approximately one-sixth (166,000 acres) where conventional tillage is common have a serious problem (Table 3-2). The problem is concentrated in several locations (Figure 3-1) with the most extensive and severe problems found in the Upper Macatawa River, Upper Rabbit River, and Upper Battle Creek Watersheds. Six of the nine water quality stations (Table 5-4) that have moderate to poor water quality lie downstream from areas identified as having an erosion problem (Figure 3-1).

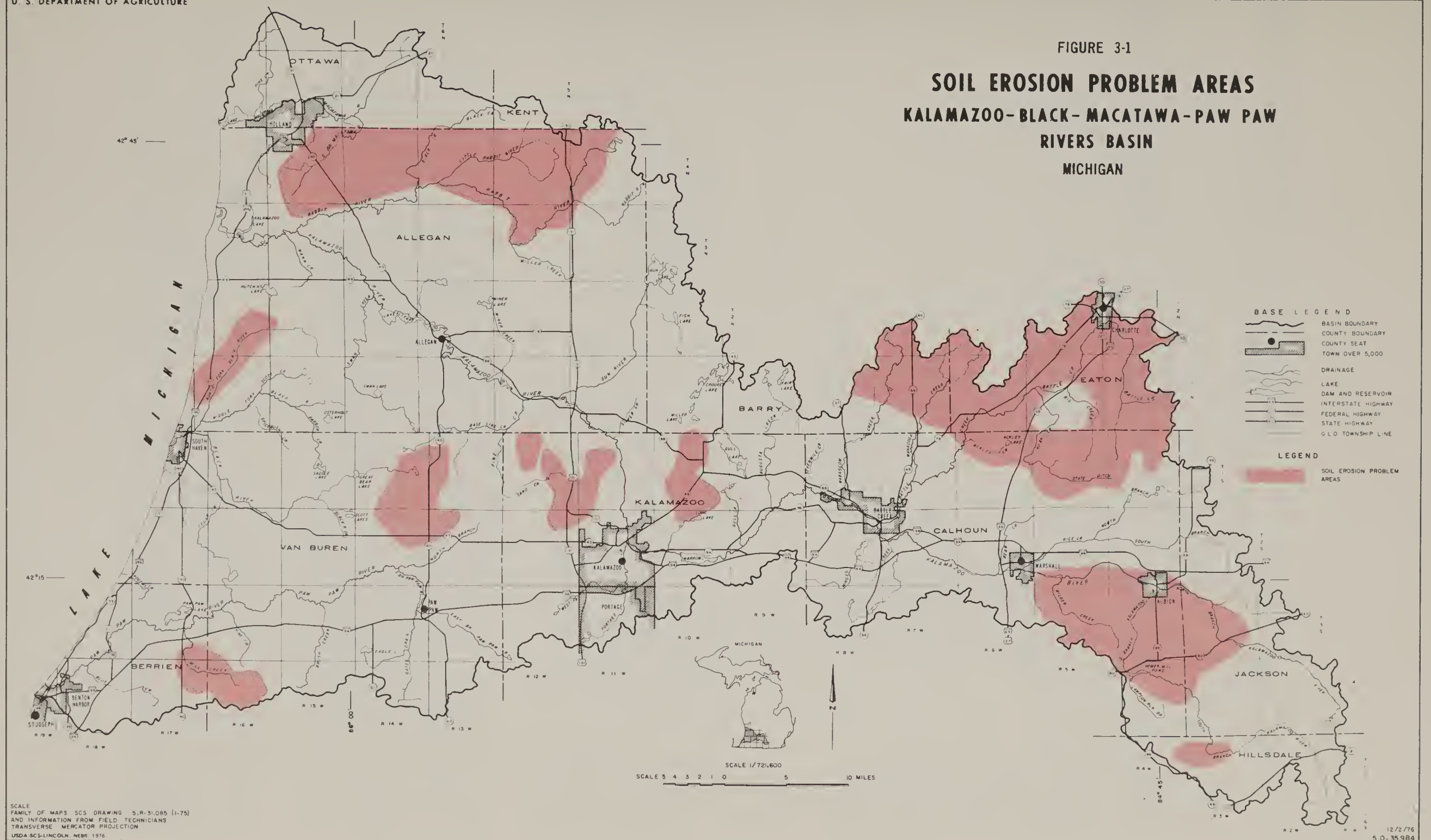
U. S. DEPARTMENT OF AGRICULTURE

FIGURE 3-1

SOIL EROSION PROBLEM AREAS

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN

MICHIGAN



SCALE
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AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION
USDA-SCS-LINCOLN, NEBR. 1976

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TABLE 3-2--CROPLAND WITH SERIOUS EROSION PROBLEMS

County	Total Cropland (Acres)	Serious Erosion Problems (Acres)	Average Erosion Rate (Tons/Acre/Year)
Allegan	298,954	35,000	7.4
Barry	44,782	3,000	6.8
Berrien	40,049	2,000	6.7
Calhoun	178,538	33,000	6.8
Eaton	44,333	16,000	7.5
Hillsdale	27,410	3,000	6.0
Jackson	44,207	11,000	6.2
Kalamazoo	93,535	15,000	5.9
Ottawa	43,719	25,000	8.1
Van Buren	186,305	23,000	6.2
Kent	4,000	Not Evaluated	-
TOTAL	1,005,832	166,000	-

From an agricultural standpoint, erosion is considered a problem if it will eventually lead to permanent loss of soil productivity. Most soils in the Basin can tolerate up to 3 to 5 tons per acre per year. However, from a water quality standpoint, erosion rates below these levels may create a problem. Erosion occurring on forest land is not a significant problem. Most erosion which does occur as a result of disturbances, e.g., grazing, logging roads, etc., is minor, on site in nature, and does not result in sedimentation.

Erosion rate differences in this complex glacially derived landscape correlate well with the origin of soil materials. Very sandy soils, such as Oakville, Spinks, and Rubicon soils, found most extensively in the western areas are the least erosive as far as sheet erosion from storm runoff is concerned. These soils are formed in sandy glacial drift and outwash materials. The heavier textured soils are formed in the glacial till materials which have high clay content. These include the Miami and Blount soils, found extensively in Allegan, Eaton, and Van Buren Counties.

Soils with considerable clay content are the better all-around agricultural soils. These soils, therefore, are cultivated continuously and have the poorest land cover in contrast to much of the very sandy soils which tend to have more permanent vegetative cover. Thus, the highest erosion rates are on the more intensely used, productive, clay based, agricultural soils.

URBAN DEVELOPMENT SITES

Erosion is a critical problem on the some 1,300 acres of the land undergoing urban transition annually. Soil loss is estimated to be more than 172,000 tons annually (Table 3-3). This erosion mainly results from storms that occur while the land cover is removed during construction. Again, erosion rates vary with soil type and relief. These rates are the highest in urban areas with heavy textured soils such as Charlotte, Battle Creek, and Albion. Rates are the lowest in the areas with sandy soils and low relief such as Benton Harbor and Holland.

TABLE 3-3--SOIL EROSION ON LAND UNDER DEVELOPMENT

Urban Area	Average Annual Acres Exposed	Tons/Acre/Year	Total Tons
Charlotte, Bellevue & Olivet	40	175	7,000
Battle Creek	265	175	46,370
Marshall	40	175	7,000
Albion	40	175	7,000
Kalamazoo, Portage & Oshtemo	455	150	68,250
Allegan, Otsego, Plainwell	50	100	5,000
Paw Paw, Lawton & Macatawa	50	125	6,250
Benton Harbor, Watervliet	170	75	12,750
South Haven	25	75	1,880
Holland	150	75	11,250
TOTAL	1,285	-	172,750

Passage of Michigan's Soil Erosion and Sedimentation Control Law (Act 347) in 1972 requires permits to be obtained for site development. Issuance of a permit is dependent upon the builder incorporating erosion and sediment control measures into his site plan. Once the permit is issued, the practices must be installed or a fine can result. Since this major step in reducing soil erosion on development sites has already been taken, urban erosion is not considered any further in this Study.

STREAMBANKS

Streambank erosion is a moderate to severe problem on 430 miles of the 1,284 number miles of streams in the Basin, according to a survey

made by the Fisheries Division of the Michigan Department of Natural Resources (Table 3-4). By the State's definition of the severeness of erosion, moderate to severe erosion occurs on "numerous locations on the stream" to "throughout the stream". Two areas of special note are the Macatawa River and Battle Creek Watersheds (Figure 3-2) which have been identified as severe problem areas.

TABLE 3-4--STREAMBANK EROSION

County	Moderate to Severe Streambank Erosion (Miles)
Allegan	104
Barry	-
Berrien	9
Calhoun	100
Eaton	49
Hillsdale	4
Jackson	21
Kalamazoo	5
Ottawa	66
Van Buren	72
BASIN TOTAL	430

Streambank erosion is especially damaging to fish habitat since all the eroded material enters the stream. For this reason the problem of streambank erosion is analyzed primarily for the purpose of improving fish habitat.

ROADSIDES

Roadside erosion is a minor problem. However, there are a few isolated areas where severe erosion occurs (Table 3-5). While the problem is not unique to any particular soil texture, the sandy soils appear to have the greatest number of raw, eroding roadside cuts. Generally, these areas are considered undesirable and should be treated. Since the problem of roadside erosion is not considered to be critical, no further analysis was made.

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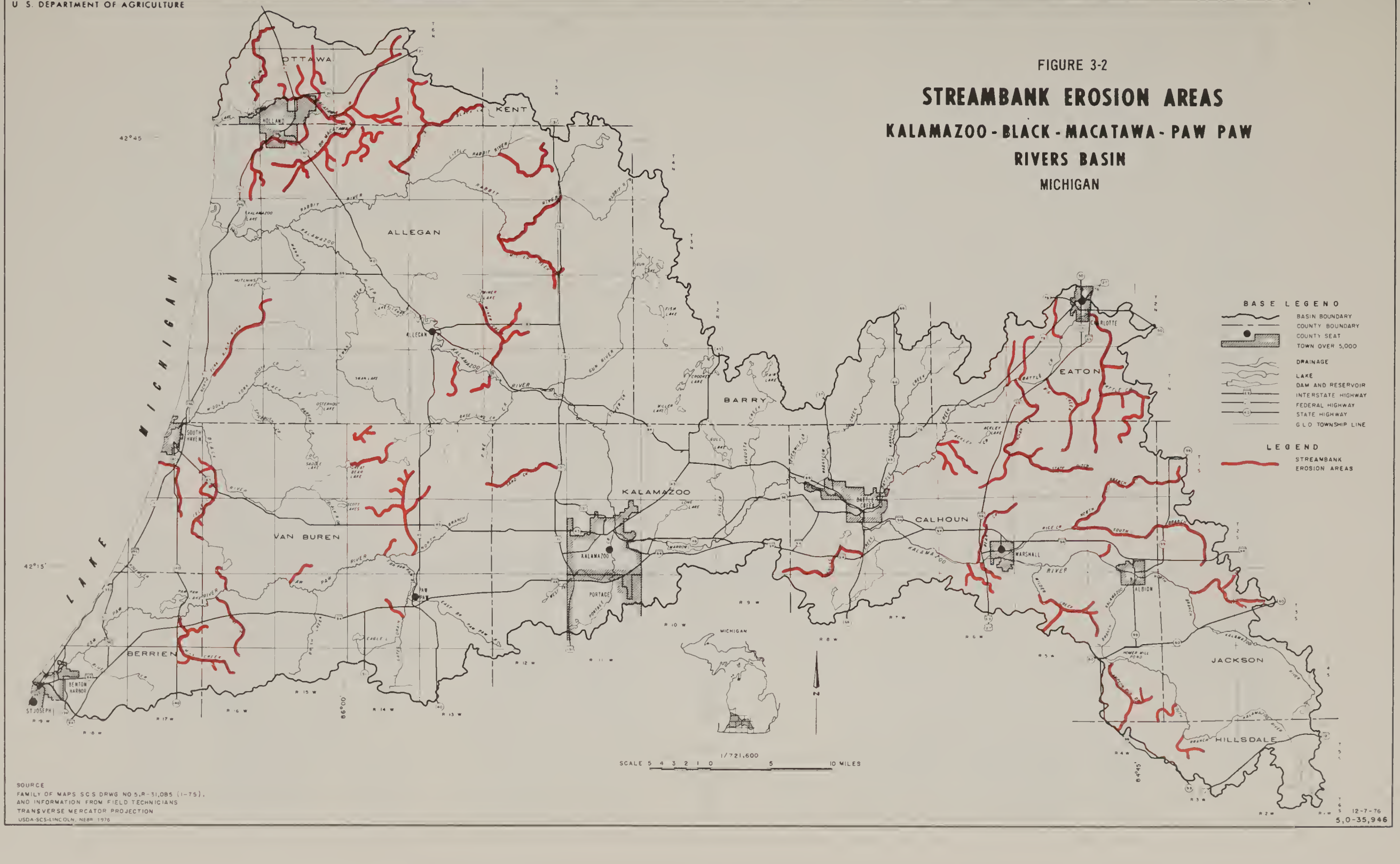
FIGURE 3-2

STREAMBANK EROSION AREAS

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN



BASE LEGEND

- BASIN BOUNDARY
- COUNTY BOUNDARY
- COUNTY SEAT
- TOWN OVER 5,000
- DRAINAGE
- LAKE
- DAM AND RESERVOIR
- INTERSTATE HIGHWAY
- FEDERAL HIGHWAY
- STATE HIGHWAY
- G L O TOWNSHIP LINE

LEGEND

- STREAMBANK EROSION AREAS

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SCALE 5 4 3 2 1 0 5 10 MILES

SOURCE
FAMILY OF MAPS SCS DRWG NO 5,R-31,085 (1-75),
AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION
USDA-SCS-LINCOLN, NEBR 1976

12-7-76

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TABLE 3-5--ROADSIDE EROSION

County	Roadside Erosion (Miles)	Exposed Roadbank Surface (Acres)
Allegan	4.6	2.8
Barry	5.3	3.2
Berrien	-	-
Calhoun	1.6	1.0
Eaton	3.6	2.2
Hillsdale	0.5	0.3
Jackson	1.4	1.5
Kalamazoo	1.6	1.0
Ottawa	-	-
Van Buren	1.4	1.5
BASIN	20.0	13.5

WATER POLLUTION

There are many point and non-point discharge sources which contribute to the pollution of the rivers and streams within the Basin. "Point" implies that the pollutants reach the water at a particular point, and include such discharges as municipal wastewater, industrial wastewater, urban stormwater runoff, septic tanks, sanitary landfills, and salt storage areas. Non-point pollutants enter streams and lakes in a diffused manner, such as animal waste, sediment, fertilizer and pesticides.

URBAN STORMWATER RUNOFF

Urban stormwater runoff has long been recognized as a source of pollution to our surface waters. Studies have shown that urban runoff contains significant quantities of plant nutrients such as nitrogen and phosphorus, organic matter, heavy metals, oils, phenols, chlorinated hydrocarbons, rubber, volatile solids and soil. In addition, in the winter, road salts are washed to the receiving water via storm sewers.

Estimated monthly stream pollutant loadings from the Kalamazoo, Battle Creek and Holland urban areas are presented in Table 3-6. For comparison purposes, monthly BOD and total phosphorus loadings of the respective municipal wastewater treatment plants are also given.

The estimated monthly stormwater BOD loading is about 1/5 to 1/3 of the loadings from the municipal Wastewater Treatment Plant for Kalamazoo and Battle Creek (Figure 3-3). The estimated monthly total phosphorus loading for these cities is 1.5 to 2 times the Wastewater Treatment Plant loading. The stormwater BOD loading in Holland is about twice the Wastewater Treatment Plant loading. This is seven to ten times the relative loading for Kalamazoo and Battle Creek. The stormwater total phosphorus loading at Holland is about three times the municipal Wastewater Treatment Plant loadings. Thus, the potential stormwater input to Lake Macatawa at Holland is considerably greater than municipal loadings. Stormwater discharges to Lake Macatawa should have more impact on the water quality than municipal Wastewater Treatment Plant inputs.

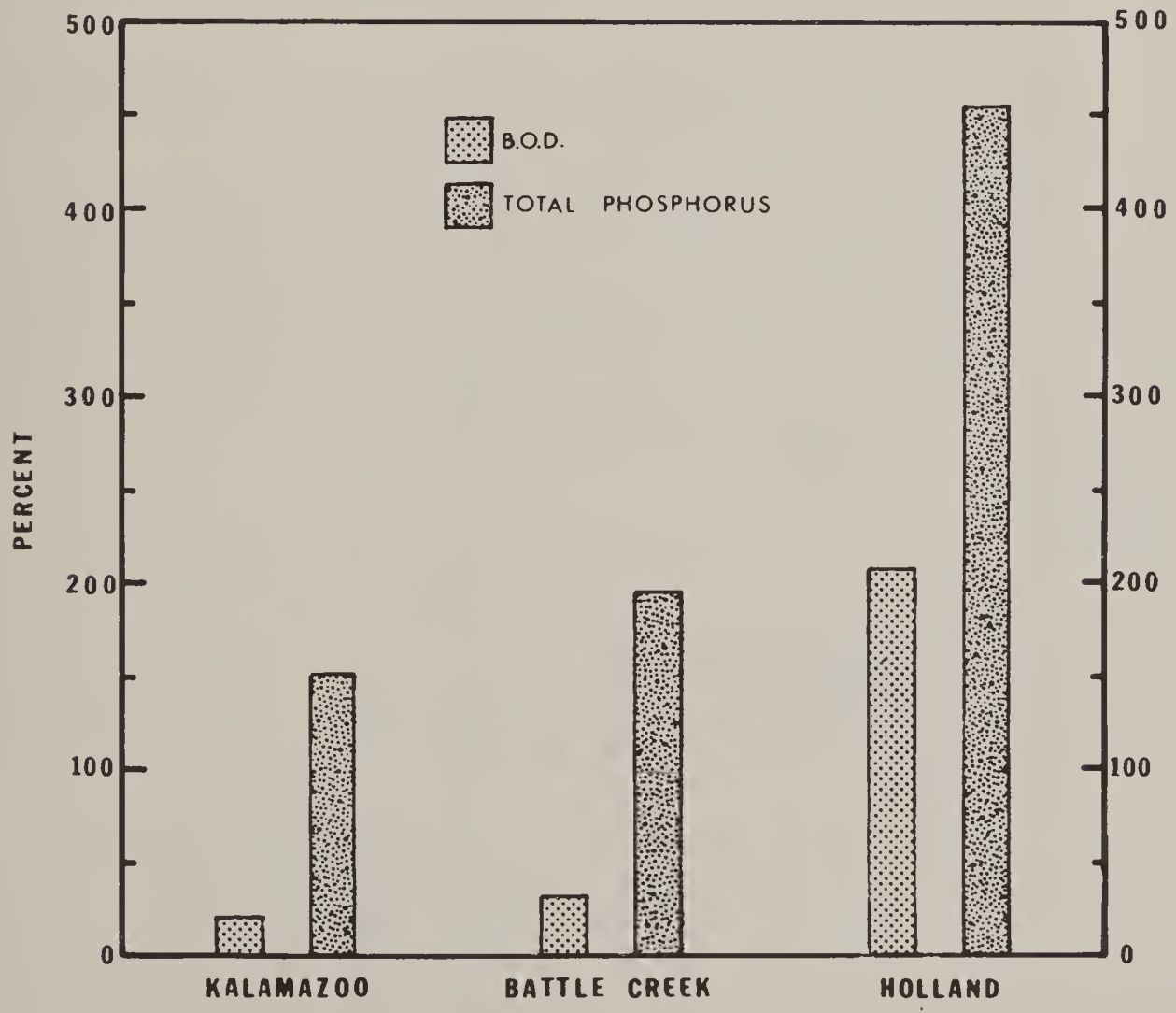

FIGURE 3-3--PERCENTAGE OF MONTHLY LOADING BY URBAN STORMWATER RELATIVE TO LOADING BY THE CORRESPONDING MUNICIPAL TREATMENT PLANT

Stormwater could have greater significance to the biota and water quality than is indicated by a simple comparison to municipal Wastewater

TABLE 3-6--MONTHLY LOADING ESTIMATES FOR SELECTED STORMWATER POLLUTANTS FROM URBAN AREAS 1/

Pollutant (lbs/mo)	Kalamazoo	Kalamazoo Municipal WWTP Loading	Battle Creek	Battle Creek Municipal WWTP Loading	Holland	Holland Municipal WWTP Loading
	(lbs/month)					
Total Solids	6,589,404		3,265,020		1,231,803	
COD 2/	922,516		457,102		172,451	
BOD 3/	131,129	702,000	64,974	239,070	24,513	13,770
Total Phosphorus	19,306	14,910	9,567	5,760	3,608	930
Lead	5,732		2,841		1,071	
Mercury	0.54		0.3		0.1	
PCB 4/	5.05		2.50		0.9	
DDT	0.48		0.25		0.1	
Fecal Coliform 5/	2.9×10^6		1.4×10^6		5.4×10^5	

1/ Estimates are based on daily accumulation rates, assuming at least one storm a month which will effect 85 percent removal of accumulated contaminants.

2/ Chemical Oxygen Demand.

3/ Biochemical Oxygen Demand.

4/ Polychorinated Biphenyls.

5/ Reported as most probably number.

Treatment Plant loadings. The shock loadings of BOD or toxic materials which enter during the first flush of a storm can have severe adverse impacts.

The values in Table 3-6 were computed by use of a model developed by the URS Research Company of California. This model considers urban runoff as a function of acres and curb miles in the watershed. The data used were supplied by the city or State Highway Departments or estimated from URS charts and tables.

In the future as municipal and industrial discharges are regulated or controlled, the loading from urban runoff will become increasingly significant. Thus, future management philosophy and policy should address the problems of both municipal and industrial sources and urban runoff source discharges. Both problems are being studied by the planning agencies, designated in accordance with Section 208 of P.L. 92-500, the Federal Water Pollution Control Act Amendments of 1972. No further analysis was made in this study.

SEDIMENTATION

Sedimentation in the Basin is degrading fish habitat, water quality, and aesthetic values. Other damage, which involves sediment in combination with organic growth, is the loss of reservoir and channel capacity. Damages resulting from sedimentation are most severe downstream from cultivated cropland areas with the previously mentioned erosion problems, especially on the Macatawa River, Little Rabbit River, and tributaries in the Battle Creek Watersheds.

The procedure used to analyze the sedimentation problem in the Basin had several components. Included were basic erosion rates, sediment delivery ratios adjusted to local soil characteristics, and amounts of local rainfall runoff from storms of varying intensity. Estimates were made of both average suspended sediment concentrations and the percent of time that concentrations were at or above different levels. More information on this procedure is found in Appendix A, Methodology.

Average concentrations of suspended sediment vary severalfold between the watersheds evaluated (Table 3-7). The average concentration at the lower end of the Black River, for example, is estimated to be 24 parts per million. The Macatawa River, in contrast, has an estimated average concentration of 256 parts per million, a tenfold difference. Suspended sediment should not exceed 25 and 75 parts per million for coldwater and warmwater fish respectively.

These concentrations do not reflect the periodic surges of much higher suspended sediment concentrations. On the Battle Creek for

example, analysis reveals that concentrations exceed 1,000 parts per million three percent of the time. At all locations the concentrations of suspended sediment exceed the average by several times during periods of high runoff. Figure 3-4 illustrates the distribution of suspended sediment concentrations in the Battle Creek by means of a concentration duration curve.

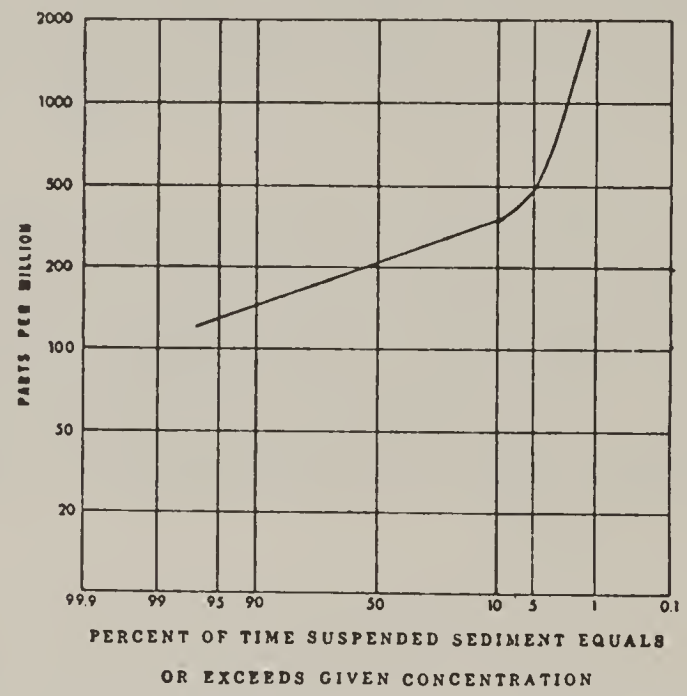

FIGURE 3-4--SUSPENDED SEDIMENT CONCENTRATION DURATION CURVE FOR BATTLE CREEK

High levels of suspended sediment in the Macatawa and Little Rabbit Rivers are the prime reasons why there is degraded water quality in these rivers. This is true to a lesser extent for the tributary streams of Battle Creek. Estimated total annual tons and acre feet of sediment yields for the evaluated watersheds illustrate the approximate amounts of sediment that would be deposited annually in reservoirs if located at these points. This also assumes reservoirs with high trap efficiencies.

ANIMAL WASTE

There are nearly 330 livestock farms in the Basin from which surface runoff pollutes both surface and ground water. Pollution from animal waste stems largely from inadequate storage and disposal methods and from the location of feedlots. Livestock waste is often spread on frozen or bare ground from which excessive surface runoff occurs. In addition, livestock feedlots may be located too close to streams or other waterways. In both cases nutrients are washed into the streams with the rain runoff.

TABLE 3-7--ESTIMATED SEDIMENT YIELD AND AVERAGE SEDIMENT CONCENTRATIONS

Watershed	Drainage Area (Sq.Miles)	Estimated Annual Sediment Yield (Tons)	(Acre Feet)	Estimated Average Concentration (Parts Per Million)
Kalamazoo River, at Battle Creek	824	53,600	30	84
Battle Creek, above Battle Creek	280	51,300	29	232
Kalamazoo River, below Kalamazoo	1,212	66,800	37	68
Kalamazoo River, below Allegan	1,595	84,700	47	61
Paw Paw River, at Benton Harbor	445	19,900	11	42
Black River, above South Haven	360	9,700	5	24
Kalamazoo River, at Saugatuck	2,020	95,700	53	54
Macatawa River, at Holland	178	38,200	21	256

Animal wastes are a source of nutrients (nitrogen, phosphorus, and potassium), and contribute to pollution of the streams. An estimated 350 tons of nutrients are lost annually in runoff from livestock areas.

Water quality tests reveal that in some of the tributary streams in the Basin fecal coliform bacteria levels are well above those recommended as a maximum for total body contact. Nitrate levels are elevated in some of the tributary streams and phosphorus levels are high at several locations, as are those of chlorides and ammonia.

Twelve areas in the Basin have a high density of livestock farms (Figure 3-5). The Macatawa River Watershed in Ottawa County has been identified as having high phosphorus and nitrate levels as well as

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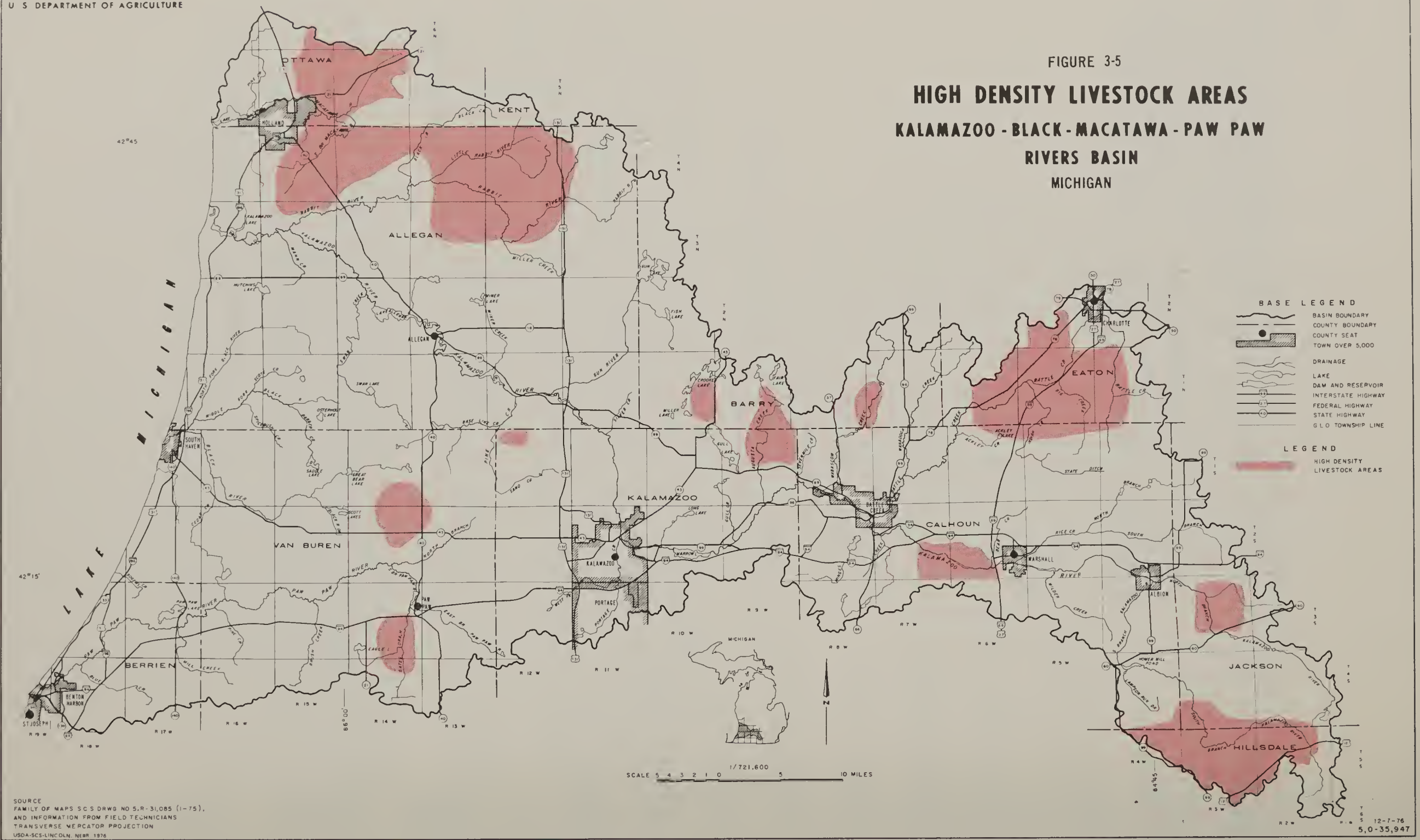
FIGURE 3-5

HIGH DENSITY LIVESTOCK AREAS

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN



SOURCE
FAMILY OF MAPS SCS DRWG NO 5,R-31,085 (1-75),
AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION
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other pollutants. The Rabbit River also has elevated phosphorus and nitrate levels. Tributaries of Battle Creek in Eaton County show high nitrate levels and a somewhat high phosphorus level. Six of nine water quality stations with moderate to poor water quality (Table 5-4) lie downstream from areas identified as having high density livestock concentrations (Figure 3-5).

FLOODING

Flooding is not a major problem in the Basin, except along portions of some of the main rivers. Fourteen small urban areas with flooding problems were identified in the upstream watersheds. Four agricultural areas were also identified with flooding and drainage problems.

URBAN FLOODING

Urban flood problems have been limited to a few relatively small areas since natural streams in the Basin generally do not experience large variations in flow. Many areas have a well defined flood plain with extensive, wet lowland areas. Development generally has avoided these areas thus far, but there is concern that as the population increases, many flood prone areas will be developed for residential, industrial, or commercial uses. This would create a serious problem.

The cities of Battle Creek, Comstock, Kalamazoo, and Parchment have developed within flood prone areas. Battle Creek has received a large degree of flood protection from an installed Corps of Engineers project. The problem of flooding is being or has been studied by the Corps for each of the other three cities. A structural flood control proposal to increase the flow capacity of the Kalamazoo River was rejected by county officials in 1971. Since then the Corps has given this project a low priority. These areas are not included in this report.

Urban flooding is presently or may be a problem in 14 areas, located in five counties. (Figure 3-6 and Table 3-8.) These areas are near existing urban areas, include attractive building sites, and have some new development nearby. Of the estimated $81,000 average annual damage, 47 percent ($38,400) occurs around Paw Paw Lake and nearly 18 percent ($14,400) at Lakewood on Davis Creek. The other 12 areas have only a few homes which have flood problems.

Analyses were made of development pressures from population centers. This analysis showed pressure for development varying from moderately strong to very intense on the identified flood problem areas. The highest pressure is near the cities of Battle Creek and Kalamazoo.(Table 3-8.)

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FIGURE 3-6

URBAN AND AGRICULTURAL FLOODING PROBLEM AREAS

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN

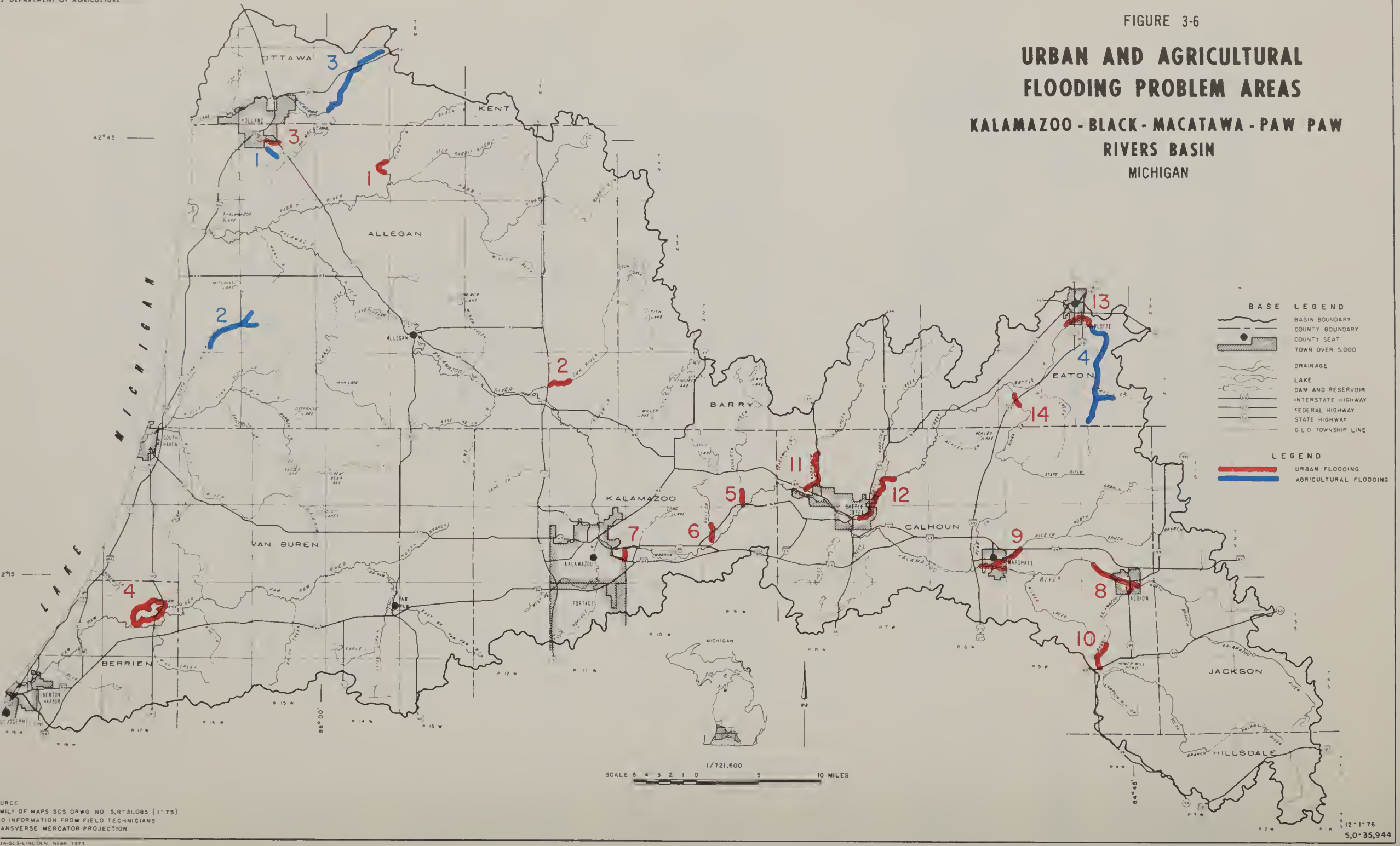

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TABLE 3-8--URBAN FLOOD PROBLEMS

Location	Miles	Acres	Average Annual Damage (Dollars)	Development Pressure 2/
ALLEGAN				
1. Black Creek at Bentheim 1/	2	311	600	MS
2. Gun River at Plainwell	2	208	4,700	S
3. North Branch of Macatawa River, Holland	1	371	300	MS
County Total	5	890	5,600	
BERRIEN COUNTY				
4. Paw Paw Lake near Watervliet	6	172	38,400	VS
County Total	6	172	38,400	
KALAMAZOO COUNTY				
5. Augusta Creek at Augusts	2	60	1,350	I
6. Gull Creek at Galesburg	2	296	--	I
7. Davis Creek at Lakewood	2	32	14,400	VI
County Total	6	388	15,750	
CALHOUN COUNTY				
8. Kalamazoo River at Albion	5	236	3,500	S
9. Kalamazoo River at Marshall	5	190	6,800	S
10. South Branch of Kalamazoo River at Homer	2	250	1,500	S
11. Wabascon Creek at Battle Creek	7	400	5,300	VI
12. Battle Creek near Battle Creek	7	950	3,400	VI
County Total	26	2,026	20,500	
EATON COUNTY				
13. Battle Creek at Charlotte	3	212	750	S
14. Indian Creek at Olivet	2	150	--	S
County Total	5	362	750	
BASIN TOTAL--FOURTEEN AREAS	48	3,838	81,000	

1/ Numbers refer to location on Figure 3-6.
2/ VI=very intense; I=intense; VS=very strong; S=strong; MS=moderately strong.

Flood plain development is discouraged by the Flood Disaster Act of 1973. This Act requires states or local communities to participate in the flood insurance program (Flood Insurance Act of 1968) and to adopt adequate flood plain ordinances with effective enforcement provisions to reduce or avoid future flood losses, as a condition to qualify for future Federal assistance. The USDA Flood Hazard Analysis Program can be used to identify the extent of flooding that can occur during the 100-year and 500-year frequency events.

This report recommends that flood plain management be adopted in all flood prone areas identified in Figure 3-6. For planning purposes, however, only Davis Creek and Paw Paw Lake are considered serious problems. No further study is made of the other 12 areas.

AGRICULTURAL FLOODING AND DRAINAGE

A wetness condition exists on approximately 20 percent (200,000 acres) of the agricultural land in the Basin. Most of this land is not presently farmed and is classified in this report as idle cropland. The wetness condition is a problem on approximately 27,000 acres because this land is currently producing crops. Wetness results in lower quality crops, reduced yields, and higher production costs. Inadequate cropland drainage was not considered a major problem by the County Task Forces.

Four cropland areas having a flooding and drainage problem were identified (Table 3-9 and Figure 3-6). Estimated average annual damages total $142,900 due to reduced crop yields, lower quality crops, higher production costs, and inefficient use of land labor and capital. To reduce this damage the landowners will have to work together since they have a common drainage outlet problem in each area.

Most of the remaining cropland with a wetness problem can be improved by individual, on-farm measures or cooperative programs involving a few farmers. For this reason this land was not inventoried.

IRRIGATION

Supplemental cropland irrigation is a prevalent practice in the Basin. In 1970, approximately 17,000 acres were irrigated according to information in *Irrigation in Michigan*, published by the Michigan Department of Natural Resources. The average yearly application was 7.6 inches, amounting to almost 11,000 acre-feet of water. Van Buren, Berrien, Ottawa and Allegan Counties are among the six leading irrigating counties in Michigan.

Surface water was reportedly inadequate for irrigation in some parts of the Basin. Thirty-eight farms in three northern townships in Berrien County have a problem. Most of the farms are located one-fourth mile or more from, and 50 to 60 feet higher than the nearest flowing stream. Therefore, it would not be feasible to use water from streams.

TABLE 3-9--AGRICULTURAL FLOOD AND DRAINAGE PROBLEMS

Location	Damage	
	Acres	Average Annual Dollars
ALLEGAN COUNTY		
1. Den Bleyker Drain, Holland	390	18,000
2. North Fork Black River, Fennville	570	26,700
OTTAWA COUNTY		
3. Macatawa River, Zeeland	1,510	70,500
EATON COUNTY		
4. Battle Creek, Brookfield Township	850	27,700
TOTAL	3,320	142,900

Ground water in this area, however, is generally plentiful. Yields of 500 gallons per minute from wells are possible in glacial deposits. Individual farm supplies could be developed by wells at 100 to 150 foot depth. No further assessment was made of irrigation problems.

LOSS OF PRIME AGRICULTURAL LAND

An estimated 2,000 acres of agricultural land are lost each year to urban growth. Urban development not only takes place on large fields of cropland but also along township and county roads. The latter is usually scattered, single-family housing on relatively large lots. As this practice goes on, tracts of farmland between roads become "land locked". Farmers located adjacent to this developed land are often forced to relocate because of the resulting higher taxes.

The full impact of this land use change cannot be measured in acres alone, since approximately one-half of the acreage consists of the most productive cropland in the Basin. Loss of this high quality or "prime" agricultural land is perhaps more critical than the decrease in the total supply of cropland.

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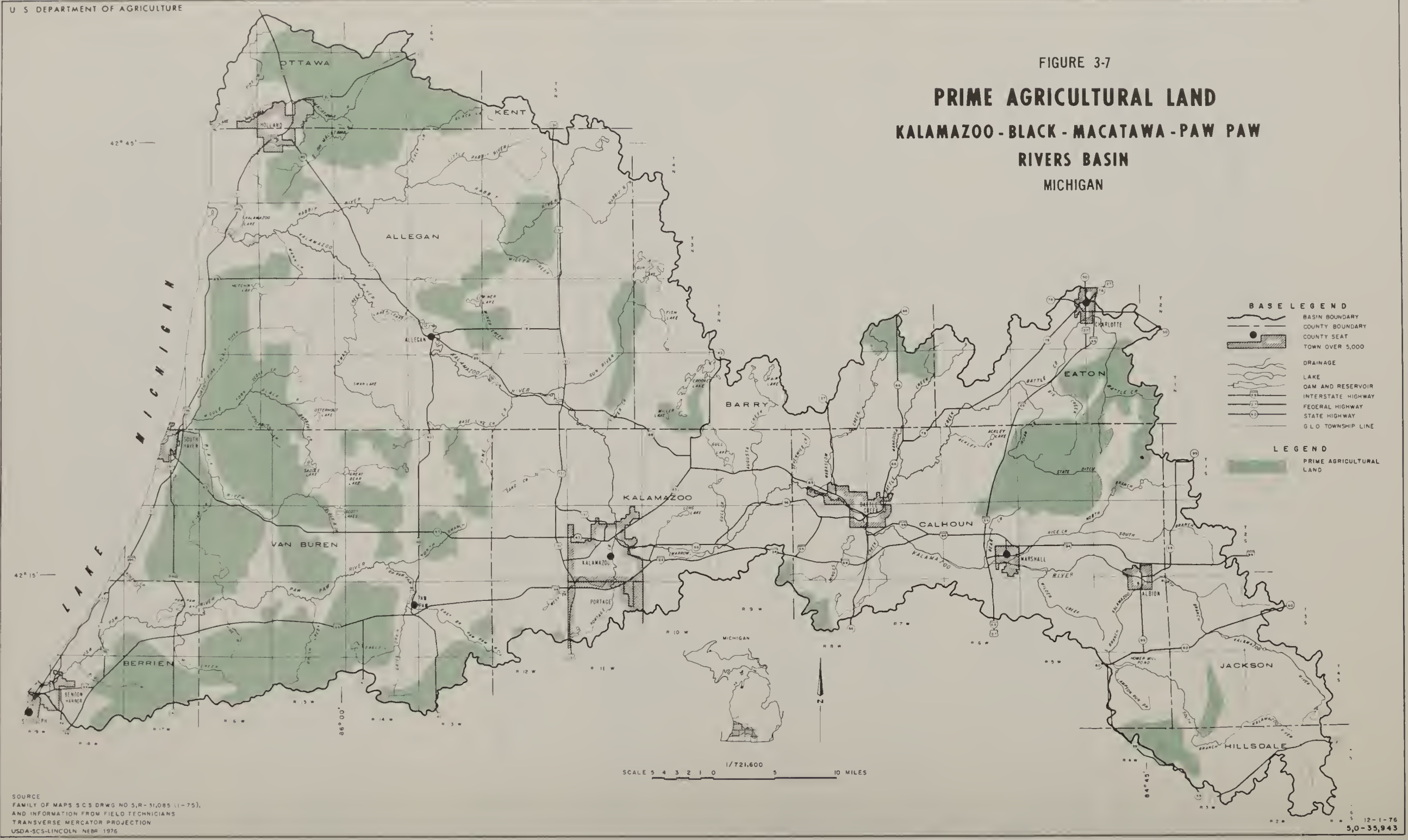
FIGURE 3-7

PRIME AGRICULTURAL LAND

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN



BASE LEGEND

- BASIN BOUNDARY
- COUNTY BOUNDARY
- COUNTY SEAT
- TOWN OVER 5,000
- DRAINAGE
- LAKE
- DAM AND RESERVOIR
- INTERSTATE HIGHWAY
- FEDERAL HIGHWAY
- STATE HIGHWAY
- G L O TOWNSHIP LINE

LEGEND

- PRIME AGRICULTURAL LAND

SOURCE
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Prime agricultural land is broadly defined in this report to include both land that can sustain high yields and land that is uniquely suited for specialty crops because of a combination of soil, physiographic, and climatic factors. These include the market basket soils (drained mucks and peats producing head lettuce, carrots, onions, and celery) and land with good characteristics for orchards and vineyards.

FIGURE 3-8--PRIME AGRICULTURAL LAND IN OTTAWA COUNTY

TABLE 3-10--PRIME AGRICULTURAL LAND

County	Prime Agricultural Land (Acres)
Allegan	53,100
Barry	5,000
Berrien	13,200
Calhoun	6,900
Eaton	6,300
Hillsdale	7,800
Jackson	3,000
Kalamazoo	900
Ottawa	23,500
Van Buren	55,400
BASIN	175,100

Some 175,100 acres of cropland have been identified as prime by the Soil Conservation Service, with the aid of many citizens. (Table 3-10 and Figure 3-7.) This land is under intensive pressure in three locations: prime fruit and vegetable sites are being lost in the Paw Paw River Basin; highly productive field cropland and vegetable land is disappearing as the Holland-Zeeland metropolitan area grows; and prime field cropland is vulnerable to urban development south of Charlotte in Eaton County.

Several County Task Forces have expressed concern for the loss of all cropland suitable for cultivation. This concern stems from a desire to maintain a strong agricultural economy as well as the rural environment for aesthetic enjoyment.

FISH HABITAT

Most fish habitat problems are a consequence of rising human use of a fixed water base. Second home development and urban sprawl, is now found on the more popular lake shores and along high quality river frontage. Such urbanization inevitably results in greater water pollution from urban runoff, septic tank seepage, soil erosion, and sedimentation.

A common fish habitat problem is streambank erosion and sedimentation caused by poor stream management in upstream watershed areas. Upper stream reaches are important for the production of young game fish and forage fish. In addition, small drains and streams are the major source of water for the rivers and lakes which produce the larger fish species. Good water quality is essential to maintain this resource.

WILDLIFE

Most wildlife habitat problems are associated with (1) large areas of intensive farming, (2) large areas of poorly managed forest land, and (3) urban expansion. Urban expansion has destroyed or degraded various types of upland habitats. In addition, clean farming in order to accommodate increased crop production and larger farm equipment is decreasing the abundance of fencerows and ditch bank cover.

Wetlands are subject to abuses that destroy or degrade their value to wildlife. Grazing, drainage, loss of vegetative buffer areas and natural aging contribute to the problem. .The 121,800 acres of identified wetland are habitat for waterfowl, amphibians, aquatic mammals and birds. These wetlands also provide necessary escape cover and feeding areas for a variety of upland species. Other values of wetland include the storage of surface water, the stabilization of runoff, and the reduction of erosion.

The term "wetlands," as used in this report and in the wildlife field generally, refers to lowlands covered with shallow and sometimes temporary or intermittent waters. They are referred to by such names as marshes, swamps, bogs, wet meadows, potholes, sloughs, and river overflow lands. Shallow lakes and ponds, usually with emergent vegetation as a conspicuous feature, are included in the definition, but the permanent waters of streams, reservoirs, and deep lakes are not included. Neither are water areas that are so temporary as to have little or no effect on the development of moist-soil vegetation.

NATURAL AND SCENIC STREAMS

The Basin has many miles of natural and scenic rivers and streams, each of which have certain qualities that attract different uses and abuses. Overuse by fishermen, boaters, and riparian landowners and the rush to acquire river frontage for building homes and cabins are beginning to take their toll. (Figure 3-9.) Extensive subdivision of property has occurred on a number of streams and is expected to increase substantially in the heavily populated areas.

FIGURE 3-9--MANY SCENIC STREAMS WILL SOMEDAY LOOK LIKE THIS SHORELINE OF PAW PAW LAKE

As river sites are developed, natural vegetation is often replaced with groomed lawns and parking lots. Development also endangers archeological, historical, and rare plant sites along the streams. Erosion occurs and visual quality may be lessened, and fish and wildlife habitat is reduced. Approximately 374 miles of streams have been identified as needing protection from urban development or overuse in the near future (Table 3-11).

RECREATION

Trends in population and in leisure time indicate there will be an increased demand for outdoor recreation. Access to recreation resources will continue to be a problem as will the lack of certain types of recreation facilities. The misuse or management of the natural resources discussed in this chapter also contribute to the recreation problem.

Finding a place to hunt within the Basin is a problem as there are only 52,400 acres of public hunting land available in State game and recreation areas. Also, according to the *1974 Michigan Recreation Plan*--prepared by the Michigan Department of Natural Resources, 75 percent of the private lands are not open to hunters. The expiration of the USDA Crop Adjustment Program will probably close more private land to hunters. Through this program farmers were offered five and 10 year contracts for the diversion of agricultural land from crop production with additional payments for a public access provision to allow hunting, fishing, trapping, and hiking. All contracts expired at the end of 1976. There is presently an estimated 400,000 acres of land (private and public) available for hunting, (Table 3-12).

Finding a place to enter a lake or stream may also be a problem, since there are only 70 access sites--six stream sites and 64 lake sites. Public access to lakes and streams allows the Michigan Department of Natural Resources to manage the fisheries resource. Based on the U.S. Bureau of Outdoor Recreation's standards, there should be one site per 4,000 people and one site for each five miles of top quality stream, there is presently a shortage of about 150 access sites.

TABLE 3-11--RIVERS AND STREAMS THREATENED BY DEVELOPMENT

River/Stream	Location	Stream (Miles)
Allegan County		
Kalamazoo River	Otsego Dam to Allegan and Lake Allegan to Kalamazoo Lake	24
Swan Creek	Swan Lake to 112th Avenue	6
Rabbit River	Section 29, Salem Township to Kalamazoo River	21
Mann Creek	124th Avenue to Kalamazoo River	6
South Br. Macatawa Rv.	Highway M-40 to county line	6
Silver Creek	County line to county line	6
		69
Barry County		
Wanondoga Creek	County line to county line	10
Wabascon Creek	Cassidy Lake to county line	9
		19
Berrien County		
Paw Paw River	County line to St. Joseph River	26
Mill Creek	County line to Paw Paw River	5
Blue Creek	Milburg to Paw Paw River	5
		36
Calhoun County		
North Branch Rice Creek	L. Drive North to South Branch Rice Creek	4
Wanondoger Creek	County line to Battle Creek River	5
South Br. Kalamazoo Rv.	County line to North Branch Kalamazoo River	16
Battle Creek	County line to Kalamazoo River	15
Kalamazoo River	County line near Albion to Upper Mill Pond	29
Wilder Creek	22 Mile Road to Kalamazoo River	6
Harper Creek	Sections 31, 32, 33, 34, Emmett Township	4
		79
Eaton County		
Indian Creek	Olivet to Battle Creek River	3
Battle Creek	Interstate 69 to Bellevue	15
		18
Hillsdale		
South Br. Kalamazoo Rv.	County line to county line	9
		9
Jackson County		
South Br. Kalamazoo Rv.	Stoney Point Road to west county line	9
North Br. Kalamazoo Rv.	Farwell Lake to Parson Road & Cornell Road to county line	23
		32
Kalamazoo County		
Augusta Creek	Hamilton Lake and county line to Augusta	11
Spring Brook	27th Street to Kalamazoo River	8
Kalamazoo River	County line to Augusta	4
Portage Creek	Hampton Lake to N. Avenue	7
		30
Ottawa County		
Macatawa Creek	Highway M-21 Zeeland Township to 104th Avenue	7
S. Br. Macatawa River	County line to Macatawa River	2
		9
Van Buren County		
Paw Paw River	Confluence North-South Branches to county line	30
North Br. Paw Paw River	Stevens Road to South Branch Paw Paw River	12
East Br. Paw Paw River	County line to West Branch Paw Paw River	12
Brush Creek	Entire length	3
Mill Creek	Headwaters to county line	6
Mentha Drain	Mentha to county line	6
Gates Drain	68th Avenue to Paw Paw	4
		73
TOTAL		374

TABLE 3-12--ESTIMATED ACRES OF LAND AVAILABLE FOR HUNTING

County	Public	Private	Total 1/
Allegan	43,700	97,400	141,100
Barry	6,000	20,900	26,900
Berrien	0	13,900	13,900
Calhoun	0	55,600	55,600
Eaton	0	13,900	13,900
Hillsdale	0	6,900	6,900
Jackson	0	17,400	17,400
Kalamazoo	1,800	38,200	40,000
Ottawa	0	17,400	17,400
Van Buren	900	66,000	66,900
BASIN	52,400	347,600	400,000

1/ Estimates based on information from *1974 Michigan Recreation Plan*.

Growing interest in outdoor recreation activities such as bird-watching, hiking, bicycling, horseback riding, and cross-county skiing has created a demand for nonmotorized recreation trails. There are 30 miles of this type of trail located in Allegan and Barry Counties. Based on the U.S. Bureau of Outdoor Recreation standard, 55 miles of single-use trails are required for 50,000 people, there is a shortage of about 660 single-use miles. That is 220 actual miles of trail managed for these uses.

There are few trails for motorized sports in the Basin because they have been developed on large public land holdings that occur only in northern Michigan. Pressures continue to increase in southern Michigan for development of facilities for motorized uses. Michigan is developing a plan for State lands, similar to a Federal one, in response to State legislation pertaining to "Off-Road-Vehicles." This would require all State land managing agencies to designate areas and trails on their land, open or closed, to off-road-vehicle use.

This Study has not evaluated the motorized trail situation. However, actions resulting from Federal and State ORV plans may affect the Basin and necessitate additions or revisions pertaining to trails.

FOREST ENVIRONMENTAL CONDITIONS

Forestry interests are concerned with two major problems. The first is the poor environmental condition of the forests. The other

is the dwindling supplies of sawtimber for forest industries in and around the Basin.

Today's forest land can be characterized by small woodlots, poor growth and vigor, poorly formed stems, a wide variation of species, and little professional management. Over 331,000 acres, or 82 percent of the forested lands, have received little or no management planning.

The objective of increased and improved management is to protect and improve the health and growth of all our trees, whether they grow along a street or in a 60-acre stand. Sound management decisions and appropriate action will help insure adequate future supplies of clean air and water, wildlife, recreational opportunities, timber, and natural aesthetics. With our nationally dwindling resource base of forested lands, it becomes increasingly important that we use what we have properly.

TIMBER SHORTAGES

Forest industries face raw material shortages. A sawtimber shortage presently exists and is expected to exist in the future in the hardwood ecosystem: the oak-hickory, elm-ash-cottonwood, maple-beech-birch, and aspen-birch (Table 3-13). Poletimber growth appears to be adequate to meet the expected demands throughout the period.

There are several reasons for the shortage of timber. In many cases, only the high quality material was removed in past harvesting operations, resulting in an undesirable residual stand left to regenerate itself. The lack of desirable species is also caused by the invasion of random species as marketable trees are removed. Often the invading trees are of little or no marketable value, and the stand is rendered useless as a source of raw material to satisfy market demands.

The lack of forest management results in low quality crops, thus reducing the amount of wood available that is suitable for established mill operations and local industries. Stands of slow-growing trees often occur in areas which are left unmanaged. Overstocking (too many trees per acre) results in very dense stands of small, poorly formed trees of little commercial value.

This growth vs. demand analysis, while alarming, does not give the true impact of the shortages because an undetermined amount of growth is not, in fact, available for harvesting. The primary factor affecting the availability of timber for forest products manufacturing, however, is the existing forest land ownership pattern. The combination of forest tract fragmentation, land use changes, owner attitudes, and

TABLE 3-13--ANNUAL TIMBER GROWTH--DEMAND

Type	Size Class	1975 Growth	1975 Demand	1975 Surplus (+) Shortage (-)	1990 Growth	1990 Demand	1990 Surplus (+) Shortage (-)	2020 Growth	2020 Demand	2020 Surplus (+) Shortage (-)
Softwood	Pole-timber	2,616 1/	635	+ 1,981	5,933	1,071	+ 4,862	7,336	1,891	+ 5,445
	Saw-timber	1,009	813	+ 196	1,491	1,371	+ 120	2,324	2,421	- 107
Hardwood	Pole-timber	38,155	17,135	+21,020	80,662	28,905	+51,745	57,745	51,046	+ 6,699
	Saw-timber	30,433	48,748	-18,315	21,448	78,193	-56,745	24,582	138,090	-113,508
TOTAL POLETIMBER		40,771	17,770	+23,001	86,595	29,976	+56,619	65,081	52,937	+ 12,144
TOTAL SAWTIMBER		31,442	49,561	-18,119	22,939	29,564	-56,625	26,906	140,511	-113,615

1/ All figures in cunits (cunit=100 cubic feet).

absentee ownership has significantly altered the amount of forest land available for timber harvesting. This area of Michigan has probably been affected as much or more than any other by these circumstances.

Fragmentation refers to the splitting of large ownerships into several smaller ownerships. This is not a problem until the blocks become so small that harvesting is no longer economically feasible on a single ownership, or where adjoining forest owners have different management objectives.

Land use changes may not be immediately evident to the casual observer. Commercial and industrial development slowly whittle away at forest land. Of more serious proportions, yet often inconspicuous, is the effect of new single family dwellings on the forest land base. For example, a family purchases two to five acres in a rural setting and erects a house along the road. Then that particular forest area is no longer available for commercial timber production. Thus, lands that appear to be forested may in fact be residential due to the presence of homes on a small part of the total tract.

An absentee owner is often a person using a tract of forest land for the purpose of recreation, preservation, speculation, or residential development. Such an owner may not recognize the multi-product potentials of the land and the capabilities for these uses to be compatible with one another. It is often difficult to bring absentee owners and potential buyers together for timber sale negotiations. Thus, distance itself may be enough to eliminate timber sale possibilities.

All of these trends highlight the need to accelerate forest management planning and education of local landowners in order to improve the quality of the forests and encourage viable forest industries in the Basin.

OBJECTIVES

The U.S. Water Resources Council has established that the overall purpose of water and land resource planning will be directed toward

improving the quality of life through contributions to the national objectives of national economic development and environmental quality. The national economic development (NED) objective is reflected in an increase in the value of the nation's output of goods and services and/or an improvement in the economic efficiency of this production. The environmental quality (EQ) objective involves the management, conservation, preservation, restoration, or improvement of the quality of natural and cultural resources and ecological systems.

Each of the problems discussed was analyzed under one or both of the two national objectives. The Study objectives were derived from the problems and are grouped by national objective (Table 3-14).

TABLE 3-14--PROBLEMS AND OBJECTIVES

National Objectives	Problems	Study Objectives
NED	1. Serious erosion on 166,000 acres of cropland.	Reduce erosion on cropland to an acceptable level.
	2. Crop damage on some 3,320 acres due to flooding and inadequate drainage.	Reduce agricultural flood damage and improve cropland drainage on existing cropland.
	3. Lack of recreational opportunities for water-based activities.	Provide additional public access to streams.
	4. Lack of recreational opportunities for land-based activities.	Provide managed recreational trails. Provide additional land for hunting.
	5. Urban flood damage at Lakewood on Davis Creek and around Paw Paw Lake.	Reduce urban flood damage.
	6. Shortage of hardwood sawtimber.	Manage and enhance additional forest land to increase fiber growth and yield, and to improve environmental conditions.

TABLE 3-14--PROBLEMS AND OBJECTIVES (cont'd)

National Objectives	Problems	Study Objectives
EQ	1. Lakes and streams polluted by nutrients from urban and rural areas.	Provide treatment of livestock wastes.
	2. Streams polluted by sediment from upland and streambank erosion.	Reduce streambank erosion. Reduce erosion on cropland.
	3. Loss and degradation of wildlife habitat.	Protect and enhance wetland wildlife habitat. Improve upland wildlife habitat.
	4. Loss of scenic areas along stream corridors.	Protect and manage stream corridors.
	5. Loss of some 1,200 acres of prime agricultural land annually to urban development.	Protect prime agricultural land.
	6. Forests are in poor environmental condition.	Manage and enhance additional forest land to increase fiber growth and yield and to improve environmental conditions.

CHAPTER IV

Desired Future

CHAPTER IV

DESIRED FUTURE

Through the County Task Forces this Study is designed to be responsive to the desires of the people in the Basin. With the realization that current economic and environmental conditions will change in the future, desired future conditions are established as goals to be achieved. These goals can then be related to the Study objectives presented in Chapter III.

ECONOMIC AND ENVIRONMENTAL DESIRES

CROPLAND

The State of Michigan has repeatedly shown interest in more fully developing its agriculture while also protecting the environment. In 1974 the Prime Land Committee of the Michigan Department of Natural Resources estimated that the state produced the equivalent of 52 percent of its food needs. Given the region's natural resource base, the Committee felt it was desirable to increase this degree of self-sufficiency to 62 percent by the year 2000, its furthest projection year. The Committee's desired levels of crop production in 1990 are significantly different from the national projections of OBERS (Acroynm for Office of Business Economics, U.S. Department of Commerce and the Economic Research Service, USDA) traditionally used in River Basin Studies (Table 4-1). The major differences are substantially increased requirements for wheat, oats, and hay desired by the State. Department of Natural Resources crop projections are not available for 2020.

While desiring to improve Michigan's agricultural economy, the Committee also felt it important that future growth in the use of fertilizers and pesticides be restricted. The consequence of this desire was that crop yields would rise an average of only 10 percent between the early 1970's and 1990. This is quite conservative when compared to yield increases developed for the national OBERS estimates presented in Chapter VI.

TABLE 4-1--DESIRED CROP PRODUCTION

Crop	Units (1,000's)	1990 OBERS	1990 DNR	2020 OBERS
Corn, grain	bu.	23,540	23,040	31,960
Soybeans	bu.	1,050	1,030	1,480
Wheat, oats	bu.	2,230	5,320	1,730
Hay	tn.	600	690	650

Closely related desired conditions include maintaining the productivity of the land resource and improving water quality. Specifically it is desired to reduce soil loss on cultivated cropland to the T-value (a maximum soil loss rate consistent with maintaining long-term productivity).

A linear programming model was developed by the Economic Research Service (USDA) to express these Basin-wide desires in terms of cropland and forest land use and production, In Table 4-2 the analysis of resulting 1990 conditions on cropland shows that there should be enough cropland to meet future food production requirements. In that year, some 47,000 acres of idle cropland should be available to serve as a reserve. An additional 118,000 acres of "other open cropland" that has not been cropped for over a decade should also be available. Its conversion to crop production may be costly, however, due to the need for substantial land clearing. Environmental constraints on crop yield increase together with higher food requirements largely explain the decreases in these "surplus" acres between the current situation and 1990.

Desired levels of livestock production, not shown in the table, but which form the basis for desired hay and silage requirements, include increases in Basin production of beef and veal, pork, turkeys, chickens and broilers, and eggs. Desired levels of both lamb and mutton, and of milk production are below current levels.

Under the desired conditions, cropland erosion would decline one-third by 1990. While somewhat higher amounts of fertilizers are expected to be applied, this reduction in the transporting medium should mean less water pollution from fertilizer and pesticide applications to cropland and pasture.

FOREST LAND

Approximately 80 percent of the forest lands are not now being managed. They therefore have potential for increased productivity and long term yields of fiber, wildlife, recreation, clean air and water, and aesthetic enhancement. It is desired that by 1990, at least one-half of the forest land should be under some form of management and two-thirds by 2020.

As part of this change in management, it is desired that timber stand improvement (TSI) measures be applied to improve fiber growth and enhance the environment over that otherwise expected. Present forest conditions indicate that over 40 percent or 163,100 acres are presently in need of cultural treatment to improve site utilization, tree growth, and vigor. These treatments include timber stand improvement measures such as weeding young stands to remove unwanted species, thinning to relieve overcrowding, releasing vigorous young quality trees, pruning selected trees to produce clear stems, removal of defective and deformed trees, and elimination of insect and disease infested individuals; site preparation; seeding and planting.

There are numerous effects that would be realized from the management changes and application of TSI measures. First, annual poletimber growth would be improved, thus accelerating the progression from the poletimber size class into sawtimber. Due to the composition of the forest resource, a decline in hardwood sawtimber growth is unavoidable. However, the decline could be lessened to the levels shown in Table 4-2 by the desired changes. Erosion from forest land, although minor compared to that from cropland, would be reduced slightly. In addition, the compatibility of the resource for outdoor recreation activities would be enhanced.

SPECIFIC ECONOMIC AND ENVIRONMENTAL DESIRES

In order to establish planning goals, specific desired economic and environmental conditions were established for the study objectives

TABLE 4-2--CURRENT AND DESIRED FUTURE CONDITIONS

	Units (1,000's)	Current Situation	Desired Future 1990	Desired Future 2020 3/
Cropland/pasture in production	acres	819	847	
Idle cropland	acres	79	47	
Other open cropland	acres	196	118	
Total	acres	1,094	1,062	
Productive				
Corn, grain	bushels	15,280	23,040	
Corn, silage	tons	370	560	
Soybeans	bushels	460	1,030	
Wheat, oats	bushels	2,410	5,320	
Hay	tons	630	690	
Fruits 1/	tons	200	190	
Vegetables	cwt	730	880	
Cost 2/	$	30,090	40,200	
Erosion Level	tons	2,315	1,520	
Conventional tillage	acres	345	322	
Minimum tillage	acres	116	167	
No tillage	acres	4	68	
Fertilizer Application	tons	58	60	
Forest Land				
Area Managed	%	18	52	68
Area Managed	acres	73	214	284
Annual Hardwood Growth 4/				
Poletimber	cunit	38	89	58
Sawtimber	cunit	30	25	28
Production Cost	index	100	101	137

1/ Apples, cherries, grapes, peaches, pears, plums, prunes.
2/ Corn, soybeans, wheat, oats, hay.
3/ Desired cropland conditions were developed only for 1990. Desired forest land conditions were developed for 1990 and 2020.
4/ Cunit = 100 cubic feet.

described in Chapter III. Desired conditions were quantified for each objective based on meetings with the various County Task Forces and State planning reports. These are summarized at the end of this chapter in Tables 4-3 and 4-4, and discussed below.

REDUCE EROSION ON CROPLAND TO AN ACCEPTABLE LEVEL

The County Task Forces indicated a desire that erosion be reduced to an acceptable level on the 166,000 acres of cropland with a critical erosion problem by 1990, to maintain soil productivity and to improve water quality by reducing the amount of sediment. This is consistent with the general desire expressed earlier for the entire Basin that soil loss be reduced to the "T" value on cropland.

REDUCE AGRICULTURAL FLOOD DAMAGE AND IMPROVE CROPLAND DRAINAGE ON EXISTING CROPLAND

Measures to reduce agricultural flood and drainage damages were not desired by many County Task Force members, however, agricultural interest groups did favor reducing damages where economically feasible. In the interest of maintaining a viable agricultural community within the Basin, a 75 percent reduction in average annual damages or by $107,300 in the problem areas was considered desirable by 1990.

PROVIDE ADDITIONAL PUBLIC ACCESS TO STREAMS

Considering the projected population growth and the water resources in the Basin, 202 public access sites were desired by 1990 and 221 by 2020.

PROVIDE ADDITIONAL LAND FOR HUNTING

Based on information in the *1974 Michigan Recreation Plan*, it is desirable that 546,000 acres of land be available for hunting in 1990 and 595,000 acres in 2020.

PROVIDE MANAGED RECREATIONAL TRAILS

Based on the Bureau of Outdoor Recreation estimate that 55 miles of single-use recreational trails are needed for 50,000 people, it

would be desirable to have 750 single use miles by 1990 and 825 miles by 2020. Assuming each trail will be managed for at least three uses, 250 miles of actual trails are desired by 1990 and 275 by 2020.

REDUCE URBAN FLOOD DAMAGE

The public desires to protect existing property at Lakewood on Davis Creek and around Lake Paw Paw in order to reduce average annual flood damage $61,300 by 1990 and $102,600 by 2020.

PROVIDE TREATMENT OF LIVESTOCK WASTES

Since improvement of the water quality of the lakes and streams is one of the high priority goals of the people in the Basin, all 329 livestock farms that constitute a significant source of pollution should be treated by 1990. Any new livestock enterprises should properly handle livestock waste in order to reduce pollution.

REDUCE STREAMBANK EROSION

The Michigan Department of Natural Resources has identified 430 miles of stream where moderate to severe bank erosion occurs. It is the desire of the County Task Forces that fish habitat be improved by controlling erosion along all 430 miles by 1990.

PROTECT AND ENHANCE WETLAND WILDLIFE HABITAT

The Task Forces indicated a desire that all 121,800 acres of identified wetland be enhanced and protected by 1990. This concurs with the State land use goals. Areas less than five acres in size were not identified.

IMPROVE UPLAND WILDLIFE HABITAT

A study of upland wildlife habitat revealed that 367,900 acres could be improved by better management. Task Forces desired that this be accomplished by 1990. This concurs with State wildlife habitat management goals.

PROTECT AND MANAGE STREAM CORRIDORS

Investigations have shown that stream corridors contain valuable wildlife habitat, threatened or rare plant sites, historical sites, and potential archeological sites. Thus, the 374 miles of river and stream identified by local, State and Federal agencies should be protected. This concurs with the philosophy expressed in the *1974 Michigan Recreation Plan*.

PROTECT PRIME AGRICULTURAL LAND

All 175,100 acres of prime agricultural land should be protected from urban or other development. This is in keeping with the thinking of the Division of Land Resource Programs, Michigan Department of Natural Resources.

MANAGE AND ENHANCE ADDITIONAL FOREST LAND

In an attempt to meet hardwood sawtimber demands of 78,200 cunits in 1990 and 138,100 cunits in 2020, and to improve forest environmental conditions, forest land under management should be increased to 52 percent (214,500 acres) of the total by 1990 and to 68 percent (284,200 acres) by 2020.

TABLE 4-3--DESIRED FUTURE CONDITIONS--1990

Study Objectives	Unit	County										
		Allegan	Barry	Berrien	Calhoun	Eaton	Hillsdale	Jackson	Kalamazoo	Ottawa	Van Buren	Basin
1. Reduce Cropland Erosion	Acres	35,000	3,000	2,000	33,000	16,000	3,000	11,000	15,000	25,000	23,000	166,000
2. Reduce Agr. Flooding & Drainage Damage	Dollars	33,600	-	-	-	20,800	-	-	-	52,900	-	107,300
3. Provide Additional Public Access	Sites	56	7	11	61	7	5	8	14	4	29	202
4. Provide Additional Hunting Land	Acres	153,000	33,000	22,000	87,000	22,000	11,000	27,000	60,000	27,000	104,000	546,000
5. Provide Managed Recrea. Trails	Miles	70	15	10	40	10	5	15	25	15	45	250
6. Reduce Urban Flooding Damage	Dollars			44,800					16,700			61,300
7. Treat Livestock Waste	Farms	30	57	4	77	53	23	16	17	31	21	329
8. Reduce Streambank Erosion	Miles	104	0	9	100	49	4	21	5	66	72	430
9. Protect Wetland Wildlife Habitat	Acres	17,200	9,900	8,100	21,800	4,900	5,100	12,800	14,200	500	27,300	121,800
10. Enhance Wetland Wildlife Habitat	Acres	17,200	9,900	8,100	21,800	4,900	5,100	12,800	14,200	500	27,300	121,800
11. Improve Upland Wildlife Habitat	Acres	132,500	19,200	10,000	60,800	13,200	8,200	15,600	42,700	12,700	53,000	367,900
12. Protect Stream Corridors	Miles	69	19	36	79	18	9	32	30	9	73	374
13. Protect Prime Agricultural Land	Acres	53,100	5,000	13,200	6,900	6,300	7,800	3,000	900	23,500	55,400	175,100
14. Manage and Enhance Additional Forest Land	Acres	-	-	-	-	-	-	-	-	-	-	214,500 1/

1/ Developed for Basin only.

TABLE 4-4--DESIRED FUTURE CONDITIONS--2020

Study Objectives	Unit	County										
		Allegan	Barry	Berrien	Calhoun	Eaton	Hillsdale	Jackson	Kalamazoo	Ottawa	Van Buren	Basin
1. Reduce Cropland Erosion	Acres	35,000	3,000	2,000	33,000	16,000	3,000	11,000	15,000	25,000	23,000	166,000
2. Reduce Agr. Flooding & Drainage Damage	Dollars	33,600	-	-	-	20,800	-	-	-	52,900	-	107,300
3. Provide Additional Public Access	Sites	57	9	13	63	9	7	10	16	6	31	221
4. Provide Additional Hunting Land	Acres	166,000	36,000	24,000	95,000	24,000	12,000	30,000	65,000	30,000	133,000	595,000
5. Provide Managed Recrea. Trails	Miles	76	16	11	44	11	5	15	30	15	52	275
6. Reduce Urban Flooding Damage	Dollars			74,600					28,000			102,600
7. Treat Livestock Waste	Farms	30	57	4	77	53	23	16	17	31	21	329
8. Reduce Streambank Erosion	Miles	104	0	9	100	49	4	21	5	66	72	430
9. Protect Wetland Wildlife Habitat	Acres	17,200	9,900	8,100	21,800	4,900	5,100	12,800	14,200	500	27,300	121,800
10. Enhance Wetland Wildlife Habitat	Acres	17,200	9,900	8,100	21,800	4,900	5,100	12,800	14,200	500	27,300	121,800
11. Improve Upland Wildlife Habitat	Acres	132,500	19,200	10,000	60,800	13,200	8,200	15,600	42,700	12,700	53,000	367,900
12. Protect Stream Corridors	Miles	69	19	36	79	18	9	32	30	9	73	374
13. Protect Prime Agricultural Land	Acres	53,100	5,000	13,200	6,900	6,300	7,800	3,000	900	23,500	55,400	175,100
14. Manage and Enhance Additional Forest Land	Acres	-	-	-	-	-	-	-	-	-	-	284,200 1/

1/ Developed for Basin only.

CHAPTER V

Natural Resource Base and Use

CHAPTER V

NATURAL RESOURCE BASE AND USE

The Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin is rich in water and land resources. Many miles of high quality streams flow through the Basin, supporting both warmwater game fish and trout populations. Some of the best cropland in the state is located within the Basin. Prime orchard and vineyard land is located along Lake Michigan. Forest land, grassland, and wetland together with cropland provide good habitat for a wide variety of wildlife species.

NATURAL RESOURCE BASE

The Basin is located in southwestern Michigan, north of the St. Joseph River Basin and south of the Grand River Basin. The Basins of the Kalamazoo, Black, Macatawa, and Paw Paw Rivers constitute a major portion of the 3,002 square mile area. Also included are the small streams between Holland and Benton Harbor that drain directly into Lake Michigan (Table 5-1).

TABLE 5-1--SUBBASIN DRAINAGE AREAS

River Basin	Area	
	Acres	Square Miles
Kalamazoo River	1,292,945	2,020
Paw Paw River	284,679	445
Black River	188,466	295
Macatawa River	110,337	172
Minor streams draining into Lake Michigan	45,036	70
TOTAL	1,921,463	3,002

Parts of 11 counties and six state planning regions are within the boundaries of the Basin (Table 5-2). Since only 1.3 percent (7,168 acres) of Kent County is within the Basin, it was not included in the Study.

TABLE 5-2--AREA MEASUREMENTS

Planning Region	County	Acres	Square Miles
2		145,798	228
	Jackson	100,542	157
	Hillsdale	45,256	71
3		647,990	1,012
	Barry	117,138	183
	Kalamazoo	218,278	341
	Calhoun	312,574	488
4		416,811	651
	Berrien	73,003	114
	Van Buren	343,808	537
6		84,170	132
	Eaton	84,170	132
8a		544,337	850
	Allegan	537,169	839
	Kent	7,168	11
14		82,357	129
	Ottawa	82,357	129
TOTAL		1,921,463	3,002

The Basin's climate is continental in type and severity. Average annual precipitation is about 32 inches, and snowfall exceeds 40 inches annually. Average July temperature is 72 degrees and average January temperature is about 24 degrees. Average January temperature is slightly warmer near Lake Michigan, being about 26 degrees. The average annual growing season ranges from about 153 days at the eastern end of the Basin to about 184 days along Lake Michigan.

The Basin has a relatively recently formed surface of glacial origin. A wide variety of glacial related deposits of the Carry substage of the Wisconsin glacial stage make up this surface (Figure 5-1). These include ground moraines of variably textured materials, terminal moraines, coarse-textured outwash, alluvial ponded areas, and other types of deposits. These glacial related materials extend to a depth

U. S. DEPARTMENT OF AGRICULTURE

FIGURE 5-1

SURFACE GEOLOGY MAP

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN

MICHIGAN

LEGEND

- SAND LAKE BEDS OF GLACIAL LAKE STAGES
- MORAINE
- GROUND MORAINE
- OUTWASH
- INLAND LAKE DEPOSITS
- GLACIAL SPILLWAYS
- ESKERS

LEGEND

- BASIN BOUNDARY
- COUNTY BOUNDARY
- COUNTY SEAT
- TOWN OVER 5,000
- TOWN UNDER 5,000
- DRAINAGE
- LAKE
- DAM AND RESERVOIR
- G L O TOWNSHIP LINE

OTTAWA · KENT · ALLEGAN · BARRY · EATON · CLINTON · VAN BUREN · KALAMAZOO · CALHOUN · JACKSON · BERRIEN · HILLSDALE

LAKE MICHIGAN

ZEELAND · HOLLAND · SAUGATUCK · DOUGLAS · FENNVILLE · WAYLAND · HOPKINS · ALLEGAN · OTSEGO · PLAINWELL · MARTIN · DELTON · BELLEVUE · OLIVET · CHARLOTTE · SOUTH HAVEN · BLOOMINGDALE · BREEDSVILLE · BANGOR · GOBLES · RICHLAND · KALAMAZOO · PARCHMENT · GALESBURG · SPRINGFIELD · BATTLE CREEK · MARSHALL · ALBION · CONCORD · HOMER · HANOVER · LITCHFIELD · HILLSDALE · NORTH ADAMS · SPRING ARBOR · COLOMA · WATERVLIET · BENTON HARBOR · ST JOSEPH · HARTFORD · LAWRENCE · PAW PAW · MATTAWAN · JAMESTOWN

MICHIGAN

SCALE 5 4 3 2 1 0 5 10 MILES

SCALE 1/430,800

SOURCE

FAMILY OF MAPS S.C.S. DRAWING NUMBER 5,R-31,085 2 (3/73) AND INFORMATION FROM FIELD TECHNICIANS.

TRANSVERSE MERCATOR PROJECTION

USDA-SCS-LINCOLN, NEBR 11/6

4/26/74

5,R-34,045

of several hundred feet in the western parts of the Basin and generally are 50 feet or less in thickness east of Battle Creek. Numerous rock outcrops and very shallow drift areas are common.

Soils are as varied as the glacial materials in which they are developed. They range from clay and silt to sand and organic materials. About 25 percent of the soils have clay loam or clay textures. These soils, such as the Miami, Marlette, and Blount soils, are found principally in Eaton County and to a lesser extent in Allegan and Van Buren Counties. Forty percent of the soils are sandy loams, and loams of intermediate textures. These soils, which include the Hillsdale, Kalamazoo, and Boyer are found primarily in Calhoun, Allegan, Barry, and Kalamazoo Counties.

Soils with loamy sand and sandy textures, which include the Oakville, Spinks, and Rubicon soils, are found on approximately 30 percent of the land. These sandy soils are largely in the western part of the Basin. The remaining five percent of the soils are organic and are distributed throughout the Basin.

A general soil association map (Figure 5-2) delineates 16 soil associations, each of which have certain predominant soil characteristics. These characteristics impose limitations on the suitability of the soils for various uses (Figure 5-3).

WATER RESOURCES

Annual precipitation of 32 inches provides adequate soil moisture for agricultural needs and maintenance of ground water levels. Runoff ranges from about 10.2 inches to about 15.6 inches. Strong base-flow conditions are maintained in most of the streams, especially in the western part of the Basin.

Ground water resources are found in both the glacial drift deposits and in certain of the underlying bedrock formations. Water from bedrock aquifers is available from wells yielding more than 500 gallons per minute in the eastern part of the Basin to 10 gallons or less per minute in the western part. Bedrock wells in Eaton and parts of Allegan and Ottawa Counties, however, yield water that is too highly mineralized for domestic or public water supplies. Yields from the overlying glacial drift generally range from 100 to 500 gallons per minute, although some areas get only 10 gallons per minute.

Historically, the abundance of high quality water has been an important factor in the development of the region. There are 1,284 miles of streams and rivers and about 2,500 lakes or ponds totaling 40,000 acres scattered throughout the Basin. These lakes range in size from Gun Lake at 2,611 acres to numerous small ponds. There are 72 ponds or lakes of 100 acres or more (Table 5-3).

TABLE 5-3--LAKES OVER 100 ACRES SURFACE AREA

County	Number of Lakes	Total Surface Acres
Allegan	21	5,900
Barry	11	5,560
Berrien	1	900
Calhoun	12	2,360
Eaton	1	130
Hillsdale	0	0
Jackson	2	340
Kalamazoo	9	3,880
Ottawa	1	2,220
Van Buren	14	2,320
BASIN	72	23,610

The quality of water in the larger streams in the Basin has been extensively evaluated in the past. This Study assessed the quality of water in the smaller tributaries which are upstream and unaffected by discharges from larger municipalities. Some degradation of the quality of water in these tributary streams has occurred.

A "Four Seasons" program of sampling and testing was conducted by the Michigan Department of Natural Resources during 1975 and 1976 at stations on 19 tributary streams that are affected largely by non-point, rural land inflows (Figure 5-4). Eight rounds of samples which reflected conditions of high, intermediate, and low flows were taken at the 19 stream locations. (Appendix C.) Four of these stations were studied to classify the types of water dwelling insects (macroinvertebrates) present as a measure of water quality. In addition, stream bottom sediments were tested at three key locations for the presence of heavy metals and synthetic hydrocarbons.

SOIL ASSOCIATIONS

Kalamazoo, Black, Macatawa, Paw Paw Rivers Basin

1. Blount-Morley Association. These are medium textured soils that lie on nearly level to gently sloping topography. They are developed in predominantly clay, clay loam, and silty clay glacial till. The internal drainage of these soils ranges from well-drained to poorly drained but they all have low permeability rates.

2. Miami-Conover Association. Medium textured soils that lie on gently sloping to rolling topography. These soils are developed in predominantly loam, silt loam, and clay loam glacial till. The internal drainage of these soils ranges from well-drained to poorly drained. The permeability rates are medium.

3. Oakville-Spinks-Ostemo Association. These are coarse textured soils on nearly level to steep topography. They are developed in sand, sandy loam, stratified sand and loamy sand, and stratified sand and gravel. They are well-drained soils with high permeability rates.

4. Kalamazoo-Oshtemo Association. Coarse textured soils on level to gently sloping topography. These soils are developed in sandy clay loam, sandy loam, and clay loam overlying stratified sand and gravel. They are well-drained soils with medium to high permeability rates.

5. Oshtemo-Kalamazoo Association. These soils are similar to those in Soil Association 4 except that they lie on sloping to steep topography and tend to be more sandy.

6. Brady-Gilford Association. These are coarse textured soils on level to depressional topography. They are developed in sandy loam to sandy clay loam outwash material overlying stratified sand and gravel. They are somewhat poorly drained soils with medium permeability rates.

7. Oakville Association. Coarse-textured soils lying on steep topography. They are developed in sand or loamy sand dunes and outwash material. They are well-drained and have high permeability rates.

8. Adrian-Houghton Association. Organic soils developed on muck over peat. They range from 12 or more inches of muck or peat over sand to more than 42 inches of peat and muck. They are level to depressional with very poor drainage.

9. Ostemo-Spinks Association. These are coarse-textured soils lying on gently sloping topography. They are developed in sandy loam, layers of sand and loamy sand, and sandy clay loam overlying sand or stratified sand and gravel dune or outwash materials. These soils are well-drained and have medium to high permeability rates.

10. Kibbie-Colwood Association. Medium textured soils lying on level to depressional topography. They are developed in loam or silt loam overlying stratified silt and fine sand. The soils are poorly drained and have medium permeability rates.

11. Granby-AuGres Association. These are coarse-textured soils developed in deep outwash sands. They are level to depressional, are poorly drained and have high permeability rates.

12. Miami-Hillsdale Association. Medium to coarse-textured soils on rolling to steep topography. They are developed in glacial drift and till ranging from sandy loam, loam and silt loam, to sandy clay loam. These are well-drained soils with medium permeability rates.

13. Selfridge-Metea-Spinks Association. Coarse textured soils on level to gently sloping topography. They are developed in loamy sands overlying clay loam, sandy clay loam, silt-loam, and sand glacial drift or till. The soils range from well-drained to somewhat poorly drained and have medium to high permeability rates.

14. Rubicon-Granby Association. Coarse-textured soils that lie on level to gently sloping topography. They are developed in deep, sandy outwash, dune, or lake plain materials. The soils range from well-drained to poorly drained. They all have high permeability rates.

15. Hillsdale-Elmdale Association. Coarse-textured soils that lie on gently sloping to rolling topography. These soils are developed in sandy loam and sandy clay loam glacial drift. They range from moderately well drained to well-drained and have medium permeability rates.

16. Houghton-Conover-Brookston Association. These are gently sloping to level soils. The Conover and Brookston soils are medium textured soils developed in loams and clay loams. They are somewhat poorly to poorly drained with medium permeability rates. The Houghton soils occupy depressional areas. They are developed in deep muck over peat and are very poorly drained.

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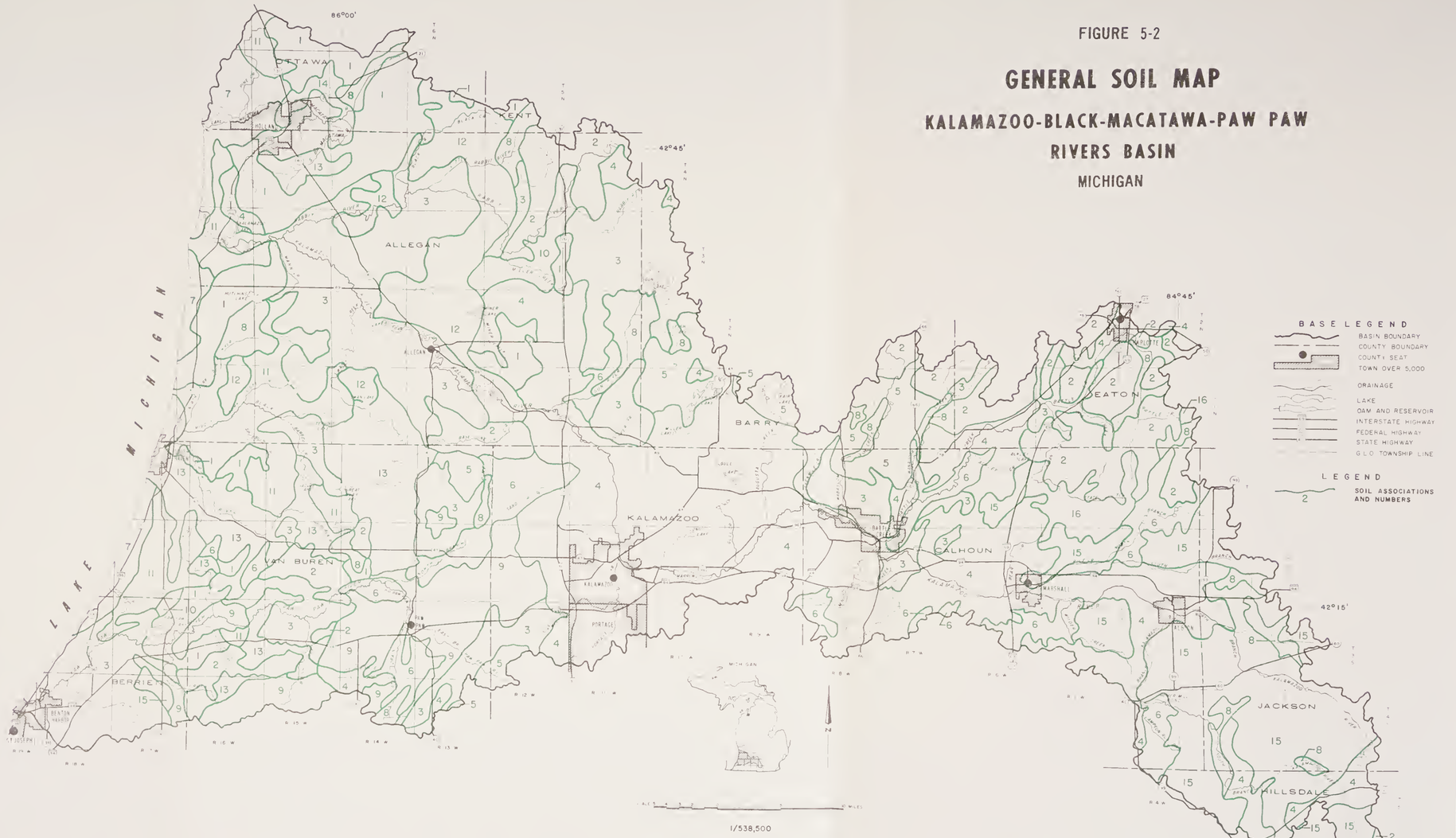


FIGURE 5-2

GENERAL SOIL MAP

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN

MICHIGAN

SOURCE:
FAMILY OF MAPS SCS DRWG. NO 5,R- 31,085(1-75).
AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION
USDA-SCS-LINCOLN, NEBR. 1976

12-14-76
5,P-35,948

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN, MICHIGAN

ESTIMATED SOIL LIMITATIONS OR SUITABILITY FOR SELECTED USES

SOIL ASSOCIATION	SOIL SERIES AND PERCENT OF ASSOCIATION		DWELLINGS & OTHER SMALL BUILDINGS		WASTE DISPOSAL		RECREATION		INTENSIVE CROPPING	WOODLAND PRODUCTIVITY
	SOIL SERIES	PCT	WITH BASEMENTS	WITHOUT BASEMENTS	WASTE TANKS	SEWAGE LAGOONS	CAMP AREAS	PLAYGROUNDS & ATHLETIC FIELDS		
1	BODUNT MORLEY METAMORA MINOR TYPES	30 25 15 20	SEVERE 2, 3 MODERATE 1, 3 SEVERE 2, 3	SEVERE 2 MODERATE 3 SEVERE 2, 3	SEVERE 2 SEVERE 1 SEVERE 2	SLIGHT SLIGHT SEVERE 4	MODERATE 2 MODERATE 1 SEVERE 2	MODERATE 2 MODERATE 1 SEVERE 2	FAIR FAIR GOOD	FAIR FAIR FAIR
2	MARLETTE CAPAC BRIDGMAN MINOR TYPES	35 30 10 25	SLIGHT SEVERE 2, 3 SEVERE 2	SLIGHT SEVERE 3 SEVERE 3	MODERATE 1 SEVERE 2 SEVERE 2	MODERATE 3 SEVERE 2 SEVERE 2	SLIGHT SEVERE 2 SEVERE 2	SLIGHT SEVERE 2 SEVERE 2	GOOD GOOD GOOD	FAIR FAIR FAIR
3	OAKVILLE SPINKS OSHTEMO MINOR TYPES	30 15 10 45	SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT	SEVERE 4 SEVERE 4 SEVERE 4	MODERATE 3 MODERATE 3 SLIGHT	SEVERE 3 MODERATE 3 SLIGHT	POOR POOR FAIR	FAIR FAIR FAIR
4	KALAMAZOO OSHTEMO SPINKS MINOR TYPES	30 20 25 25	SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT	SEVERE 4 SEVERE 4 SEVERE 4	SLIGHT SLIGHT MODERATE 3	SLIGHT SLIGHT MODERATE 3	FAIR FAIR POOR	FAIR FAIR FAIR
5	OSHTEMO KALAMAZOO MIAMI HILLSDALE MINOR TYPES	30 15 10 10 35	SLIGHT SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT MODERATE 1 SLIGHT	SEVERE 4 SEVERE 4 MODERATE 4 SEVERE 4	SLIGHT SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT SLIGHT	FAIR FAIR GOOD FAIR	FAIR FAIR FAIR FAIR
6	BRADY GILFORD BROOKSTON MINOR TYPES	35 15 15 35	SEVERE 2 SEVERE 2 SEVERE 2	SEVERE 2, 3 SEVERE 2 SEVERE 2	SEVERE 2 SEVERE 2 SEVERE 2	SEVERE 4 SEVERE 4 SEVERE 3	SEVERE 3 SEVERE 2 SEVERE 2	SEVERE 3 SEVERE 2 SEVERE 2	FAIR FAIR GOOD	POOR POOR FAIR
7	OAKVILLE SPINKS MINOR TYPES	65 15 20	SLIGHT SLIGHT	SLIGHT SLIGHT	SLIGHT SLIGHT	SEVERE 4 SEVERE 4	MODERATE 3 MODERATE 3	SEVERE 3 MODERATE 3	POOR POOR	FAIR FAIR
8	ADRIAN HOUGHTON BRADY BROOKSTON MINOR TYPES	35 25 15 10 15	SEVERE 2, 3 SEVERE 2, 3 SEVERE 2 SEVERE 2	SEVERE 2, 3 SEVERE 2, 3 SEVERE 2, 3 SEVERE 2	SEVERE 2, 3 SEVERE 2, 3 SEVERE 2 SEVERE 2	SEVERE 2, 3 SEVERE 2, 3 SEVERE 4 SEVERE 2	SEVERE 2 SEVERE 2 SEVERE 2 SEVERE 2	SEVERE 2 SEVERE 2 SEVERE 2 SEVERE 2	FAIR POOR FAIR GOOD	POOR POOR POOR FAIR
9	OSHTEMO SPINKS OAKVILLE MINOR TYPES	30 15 30 25	SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT	SLIGHT SLIGHT SLIGHT	SEVERE 4 SEVERE 4 SEVERE 4	SLIGHT MODERATE 3 MODERATE 3	SLIGHT MODERATE 3 SEVERE 3	FAIR POOR POOR	FAIR FAIR FAIR
10	KIBBIE COLWOOD HILLSDALE MINOR TYPES	40 25 10 25	SEVERE 2, 3 SEVERE 2, 3 SLIGHT	SEVERE 2, 3 SEVERE 2, 3 SLIGHT	SEVERE 2 SEVERE 2, SLIGHT	SEVERE 2, SEVERE 2, SEVERE 4	SEVERE 2 SEVERE 2 SLIGHT	SEVERE 2 SEVERE 2 SLIGHT	GOOD GOOD FAIR	FAIR POOR FAIR
11	GRANBY AU GRES OAKVILLE MINOR TYPES	40 30 20 10	SEVERE 2 SEVERE 2 SLIGHT	SEVERE 2 SEVERE 2 SLIGHT	SEVERE 2 SEVERE 2 SLIGHT	SEVERE 2, 3 SEVERE 2 SEVERE 4	SEVERE 2 SEVERE 2 MODERATE 3	SEVERE 2 SEVERE SEVERE 3	FAIR POOR POOR	POOR POOR FAIR
12	MIAMI HILLSDALE KALAMAZOO BROOKSTON MINOR TYPES	30 25 15 15 15	SLIGHT SLIGHT SLIGHT SEVERE 2	SLIGHT SLIGHT SLIGHT SEVERE 2	MODERATE 1 SLIGHT SLIGHT SEVERE 2	MODERATE 4 SEVERE 4 SEVERE 4 SEVERE 2	SLIGHT SLIGHT SLIGHT SEVERE 2	SLIGHT SLIGHT SLIGHT SEVERE 2	GOOD FAIR FAIR GOOD	FAIR FAIR FAIR FAIR
13	SELFRIDGE METEA SPINKS MINOR TYPES	40 20 10 30	SEVERE 2 SLIGHT SLIGHT	SEVERE 2 SLIGHT SLIGHT	SEVERE 2 MODERATE 3 SLIGHT	SEVERE 2 MODERATE 4 SEVERE 4	MODERATE 2 MODERATE 3 MODERATE 3	MODERATE 2 MODERATE 3 MODERATE 3	FAIR FAIR POOR	POOR FAIR FAIR
14	RUBICON GRANBY CROSWELL MINOR TYPES	25 25 15 35	SLIGHT SEVERE 2 SEVERE 2	SLIGHT SEVERE 2 MODERATE 2	SLIGHT SEVERE 2 SEVERE 2	SEVERE 4 SEVERE 2, 3 SEVERE 2, 4	SEVERE 3 SEVERE 2 MODERATE 3	SEVERE 3 SEVERE 2 SEVERE 3	POOR FAIR POOR	GOOD POOR GOOD
15	HILLSDALE ELMDALE BROOKSTON MINOR TYPES	50 20 15 15	SLIGHT SEVERE 2 SEVERE 2.	SLIGHT MODERATE 2 SEVERE 2.	SLIGHT SEVERE 2 SEVERE 2	SEVERE 4 SEVERE 2, 4 SEVERE 2	SLIGHT MODERATE 2 SEVERE 2	SLIGHT MODERATE 2 SEVERE 2	FAIR FAIR GOOD	FAIR FAIR FAIR
16	HOUGHTON CONOVER BROOKSTON MINOR TYPES	30 25 20 20	SEVERE 2, 3 SEVERE 2 SEVERE 2	SEVERE 2, 3 SEVERE 2 SEVERE 2	SEVERE 2, 3 SEVERE 2 SEVERE 2	SEVERE 2, 3 SEVERE 2 SEVERE 2	SEVERE 2 MODERATE 2 SEVERE 2	SEVERE 2 MODERATE 2 SEVERE 2	FAIR GOOD GOOD	POOR FAIR FAIR

EXPLANATION OF COLUMNS IN THE TABLE

SOIL ASSOCIATION
THE NUMBERS IN THIS COLUMN CORRESPOND WITH THE NUMBERED SOIL ASSOCIATIONS ON THE GENERAL SOIL MAP. EACH SOIL ASSOCIATION IS NAMED FOR THE MAJOR SOILS.

SOIL SERIES & PERCENT OF ASSOCIATION:
THIS COLUMN SHOWS THE APPROXIMATE PERCENT OF EACH MAJOR SOIL IN EACH ASSOCIATION AND THE TOTAL PERCENT OF ALL THE MINOR SOILS.

DWELLINGS-WITH BASEMENTS:
RATINGS ARE FOR UNDISTURBED SOILS THAT ARE EVALUATED FOR SINGLE FAMILY DWELLINGS AND OTHER STRUCTURES WITH SIMILAR FOUNDATION REQUIREMENTS. EXCLUDED ARE BUILDINGS OF MORE THAN THREE STORIES AND OTHER BUILDINGS WITH FOUNDATION LOADS IN EXCESS OF THOSE EQUAL TO THREE STORY DWELLINGS. NO SPECIFIC BEARING STRENGTH IS ESTIMATED OR IMPLIED.

DWELLINGS-WITHOUT BASEMENTS:
THE SAME QUALIFICATIONS AS GIVEN ABOVE FOR DWELLINGS-WITH BASEMENTS APPLY HERE EXCEPT THAT SEASONAL HIGH WATER TABLES ARE NOT AS RESTRICTIVE.

WASTE DISPOSAL-SEPTIC TANK ABSORPTION FIELDS:
RATINGS ARE FOR SHALLOW, SUBSURFACE TILE ABSORPTION FIELDS AND DO NOT INCLUDE ALTERNATIVE SYSTEMS.

WASTE DISPOSAL-SEWAGE LAGOONS:
RATINGS ARE FOR SHALLOW LAKES USED TO HOLD SEWAGE FOR THE TIME REQUIRED FOR BACTERIAL ACTION.

RECREATION-CAMP AND PICNIC AREAS:
RATINGS APPLY TO SOILS TO BE USED INTENSIVELY FOR TENTS AND SMALL CAMP TRAILERS AND THE ACCOMPANYING ACTIVITIES OF OUTDOOR LIVING AND FOR PARK-TYPE PICNIC AREAS.

RECREATION-PLAYGROUNDS AND ATHLETIC FIELDS:
RATINGS APPLY TO SOILS TO BE USED INTENSIVELY FOR PLAYGROUNDS FOR BASEBALL, FOOTBALL, VOLLEYBALL, AND OTHER SIMILAR ORGANIZED GAMES. THESE AREAS ARE SUBJECT TO INTENSIVE FOOT TRAFFIC.

INTENSIVE CROPPING:
THE RATINGS ARE BASED ON THE POTENTIAL PRODUCTIVITY OF SOILS TO PRODUCE SUSTAINED CORN YIELDS UNDER HIGH LEVELS OF MANAGEMENT.

WOODLAND PRODUCTIVITY:
THE RATINGS ARE BASED ON THE POTENTIAL PRODUCTIVITY OF SOILS FOR THEIR PRIMARY ADAPTED SPECIES.

DATA DEVELOPED BY
USDA SOIL CONSERVATION SERVICE

GENERAL SOIL MAP

THE GENERAL SOIL MAP OF THE KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN IN MICHIGAN SHOWS 16 MAIN PATTERNS OF SOILS CALLED SOIL ASSOCIATIONS. EACH ASSOCIATION CONTAINS A FEW MAJOR SOILS AND SEVERAL MINOR SOILS, AND IS NAMED FOR THE MAJOR SOILS. SOILS IN ONE ASSOCIATION MAY BE IN ANOTHER, BUT IN A DIFFERENT PATTERN.

THE GENERAL SOIL MAP IS USEFUL TO PEOPLE WHO DESIRE A GENERAL KNOWLEDGE OF THE SOILS TO COMPARE DIFFERENT PARTS OF THE BASIN OR TO KNOW THE LOCATION OF LARGE TRACTS THAT ARE SUITABLE FOR A CERTAIN KIND OF FARM OR NON-FARM LAND USE. SUCH A MAP IS NOT SUITABLE FOR PLANNING THE MANAGEMENT OF A FARM OR FIELD, OR FOR SELECTING THE EXACT LOCATION OF A ROAD, BUILDING, OR SIMILAR STRUCTURE BECAUSE THE SOILS IN ANY ONE ASSOCIATION ORDINARILY DIFFER IN SLOPE, DEPTH, DRAINAGE, OR OTHER CHARACTERISTICS THAT AFFECT MANAGEMENT.

DETAILED INFORMATION ON SOILS AND SPECIFIC USES ARE AVAILABLE FOR MUCH OF THE BASIN. FOR THIS DETAILED INFORMATION, PLEASE CONTACT THE FIELD OFFICE OF THE SOIL CONSERVATION SERVICE IN THE INDIVIDUAL COUNTIES CONCERNED.

SOIL INTERPRETATIONS

THE INTERPRETIVE TABLE ENTITLED "ESTIMATED SOIL LIMITATIONS OR SUITABILITY FOR SELECTED USES" PROVIDES SOIL INTERPRETATIONS FOR EIGHT SPECIFIC USES FOR EACH OF THE 16 SOIL ASSOCIATIONS SHOWN ON THE GENERAL SOIL MAP. THE APPROXIMATE PERCENT OF THE ASSOCIATION OF EACH MAJOR SOIL AND THE TOTAL PERCENT OF ALL OF THE MINOR SOILS IS GIVEN. ESTIMATED LIMITATIONS OR SUITABILITY FOR EACH OF THE NAMED SOILS AND FOR EACH OF THE EIGHT USES IS GIVEN IN TERMS OF SLIGHT, MODERATE, OR SEVERE LIMITATIONS, OR GOOD, FAIR, AND POOR SUITABILITY. BESIDE EACH OF THE RATINGS THE LIMITING SOIL PROPERTIES OR FEATURES ARE GIVEN BY LISTING ONE OR MORE NUMBERS. THESE NUMBERS CORRESPOND WITH THOSE LISTED IN THE "KEY TO PRINCIPAL SOIL LIMITATIONS", AT THE BOTTOM OF THE TABLE. SOILS RATED AS SLIGHT ARE ESTIMATED TO HAVE NO PRINCIPAL SOIL LIMITATIONS AND ARE NOT REFERENCED TO THE KEY.

SOIL LIMITATION CLASSES

SOILS RATED AS "SLIGHT" HAVE FEW OR NO LIMITATIONS FOR THE USE. SOILS RATED AS "MODERATE" HAVE LIMITATIONS WHICH REDUCE TO SOME DEGREE THEIR DESIRABILITY WHEN USED FOR THE PURPOSE BEING CONSIDERED. THEY REQUIRE SOME CORRECTIVE MEASURES. SOILS RATED AS "SEVERE" HAVE UNFAVORABLE SOIL CHARACTERISTICS THAT SEVERELY RESTRICT THEIR USE AND DESIRABILITY FOR THE PURPOSE. A SEVERE RATING DOES NOT MEAN THE SOIL CANNOT BE USED FOR A SPECIFIC USE. IT DOES INDICATE PROBLEMS CAN ARISE DURING OR AFTER APPLICATION OF THE USE UNLESS SPECIAL DESIGN, ENGINEERING, OR OTHER CORRECTIVE MEASURES ARE USED TO OVERCOME THE LIMITATIONS. COSTS ARE USUALLY GREATER THAN ON SOILS RATED SLIGHT OR MODERATE, AND MANY TIMES THESE COSTS ARE PROHIBITIVE.

SOIL SUITABILITY RATING

WHERE USED FOR "INTENSIVE CROPPING", "GOOD" INDICATES SOILS ARE CAPABLE OF PRODUCING SUSTAINED CORN YIELDS OF GREATER THAN 90 BUSHEL OF CORN PER ACRE UNDER HIGH LEVELS OF MANAGEMENT. "FAIR" INDICATES SOILS THAT WILL PRODUCE 70 TO 90 BUSHELS OF CORN AND "POOR" INDICATES SOILS THAT WILL PRODUCE LESS THAN 70 BUSHELS OF CORN PER ACRE.

WHERE USED FOR "WOODLAND PRODUCTIVITY", "GOOD" INDICATES SOILS ARE CAPABLE OF PRODUCING GREATER THAN 0.85 CUNITS. (CUNIT = 100 CUBIC FEET PER ACRE PER YEAR FOR ADAPTED TREE SPECIES. "FAIR" INDICATES SOILS THAT WILL PRODUCE 0.70 TO 0.85 CUNITS AND "POOR" INDICATES THOSE SOILS THAT WILL PRODUCE LESS THAN 0.70 CUNITS PER ACRE PER YEAR.

COLORED CIRCLES

THE COLORED CIRCLES SHOW THE PROPORTIONATE EXTENT, OR RELATIVE PERCENTAGE, OF THE LIMITATIONS OR SUITABILITY OF EACH SOIL ASSOCIATION AS A WHOLE FOR A SPECIFIC USE.

- SLIGHT OR NO LIMITATIONS OR GOOD SUITABILITY
- MODERATE LIMITATIONS OR FAIR SUITABILITY
- SEVERE LIMITATIONS OR POOR SUITABILITY
- MINOR SOILS NOT RATED BECAUSE OF THEIR COMPLEXITY.

KEY TO PRINCIPAL SOIL LIMITATIONS

1 EXCESSIVE SLOPE FOR INTENDED USE
2 SEASONAL HIGH WATER TABLE
3 ADVERSE SOIL TEXTURE
4 EXCESSIVE PERMEABILITY

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN

COMPREHENSIVE BASIN STUDY

SOIL INTERPRETATIONS

U.S. DEPARTMENT OF AGRICULTURE — DECEMBER 1976

Economic Research Service, Forest Service, and Soil Conservation Service

FIGURE 5-3

12-13-76
S.S-35,994

USDA-SCS-LINCOLN, NEBR. 1977

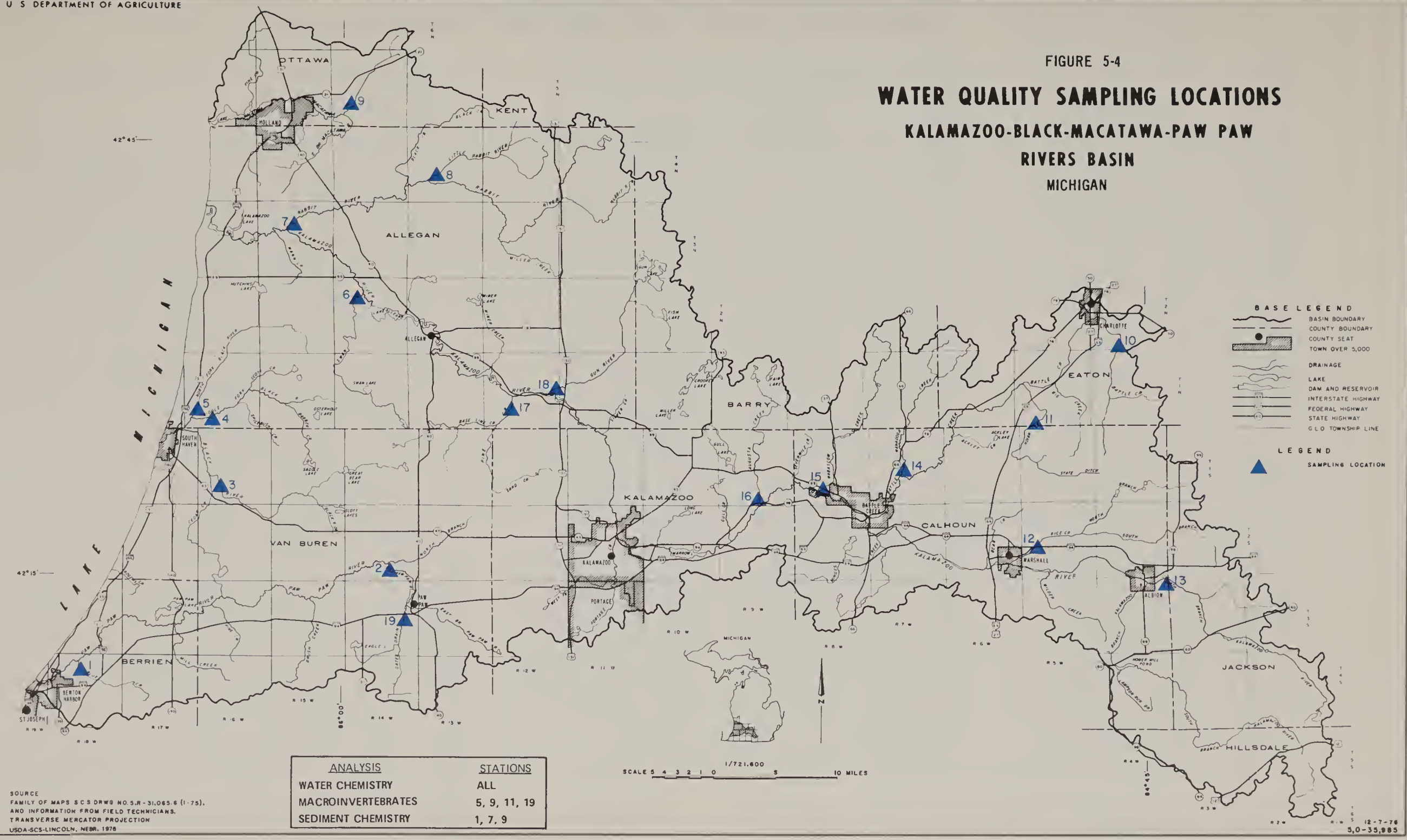
U S DEPARTMENT OF AGRICULTURE

FIGURE 5-4

WATER QUALITY SAMPLING LOCATIONS

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN

MICHIGAN



ANALYSIS	STATIONS
WATER CHEMISTRY	ALL
MACROINVERTEBRATES	5, 9, 11, 19
SEDIMENT CHEMISTRY	1, 7, 9

SOURCE
FAMILY OF MAPS SCS DRWG NO. S.R-31,065.6 (1-75).
AND INFORMATION FROM FIELD TECHNICIANS.
TRANSVERSE MERCATOR PROJECTION
USDA-SCS-LINCOLN, NEBR. 1976

12-7-76
5,0-35,985

All stations were sampled and tested for 30 water chemistry parameters. The stations were ranked on the basis of the parameters most significant to water quality (Table 5-4).

Three obvious water quality groupings emerged. Ten of the streams have good to high quality water. These 10 streams reflect standards of water quality characteristic of the higher quality, colder water streams in southern Michigan. Eight stations possess moderate quality water. These reflect standards of water quality characteristic of southern Michigan warmwater streams that are enriched. One stream, the Macatawa, has degraded water quality. This stream has high levels of enrichment and it is characteristic of poor quality, warmwater streams in southern Michigan.

It was also noted, seven of the nine water quality stations that have moderate to poor water quality (Stations 5, 7, 8, 10, 11, 19, and 9--Table 5-4), lie downstream from areas with critical erosion problems and/or high livestock densities (Figures 3-1 and 3-5).

Three of the four streams examined for macroinvertebrates had moderate to good biological characteristics in terms of water quality. One stream, Gates Drain, revealed a moderate to poor biological condition. However, factors other than the chemical parameters appear to be the cause of this, indicating the need for additional investigation.

The three streams on which bottom sediments were sampled were tested for 10 heavy metals and 20 synthetic hydrocarbons. Blue Creek possessed high arsenic and zinc concentrations and Rabbit River had an elevated arsenic level. Other metals did not occur at significantly elevated levels. These metals may be residual of past pesticide applications. Nineteen of 20 synthetic hydrocarbons were below the levels of test sensitivity. DDE was detected in the Blue Creek sample at a very low concentration.

WILDLIFE RESOURCES

Wildlife can be grouped as either migratory or resident. Migratory wildlife are bird species that include the ducks, geese, woodcock, mourning dove, and most songbirds. Some of these migratory species spend a portion of the year in the area for nesting and raising their young, during the spring and fall migrations, while others stop off in the area to feed and rest.

TABLE 5-4--WATER QUALITY RANKING OF STREAMS SAMPLED

Station	Parameter							Rank
	Nitrite-Nitrate	Ammonia	Organic Nitrogen	Total Phosphorus	Soluble Ortho-Phosphate	Suspended Solids	Iron	
Good Quality								
1. Blue Creek	10	4	1	8	8	15	11	9
2. Paw Paw S. Br.	9	12	2	7	7	3	4	6
4. Black River, N.Br.	3	6	11	11	8	3	9	8
6. Swan Creek	2	2	3	8	10	1	1	1
12. Rice Creek	7	8	13	4	4	2	8	7
13. Kalamazoo N. Br.	13	2	6	1	1	9	5	4
14. Wanadoger Creek	8	9	6	10	11	8	7	10
15. Wabascon Creek	1	5	9	3	3	9	2	3
16. Augusta Creek	12	1	3	2	2	5	3	2
17. Base Line Creek	4	6	9	5	5	6	6	5
Moderate Quality								
3. Black River S. Br.	5	10	13	17	15	15	15	12
5. Black River N. Br.	14	13	15	12	12	12	13	12
7. Rabbit River	17	11	12	19	19	12	14	16
8. Little Rabbit River	16	13	17	15	14	15	17	18
10. Battle Creek	11	15	16	14	16	6	12	12
11. Indian Creek	18	16	19	15	17	9	10	16
18. Gun River	6	18	5	5	5	18	16	11
19. Gates Drain	14	17	6	13	13	12	18	15
Poor Quality								
9. Macatawa River	19	19	18	18	18	19	19	19

The Basin lies in the migration corridor for two major flocks of Canada geese. They are the Mississippi Valley flock which numbers some 300,000 and the Tennessee Valley flock which numbers 150,000. Each spring and fall these birds concentrate on the Allegan State Game area in Allegan County, the Kellogg Bird Sanctuary in Barry County, and the Fort Custer area in Calhoun and Kalamazoo Counties. The Allegan Game Area, Kellogg Bird Sanctuary, and many farm ponds are also utilized as wintering areas by Canada geese (Figure 5-5). Approximately 10,000 geese winter at Allegan and 2,000 at the Kellogg Sanctuary.

FIGURE 5-5--CANADIAN GEESE WHICH HAVE WINTERED ON A FARM POND

Resident wildlife species include the ring-necked pheasant, bob-white quail, ruffed grouse, white-tailed deer, cottontail rabbit, raccoon, red fox, muskrat, beaver, moles, mice, and various reptiles and amphibians. Some of the many resident bird species include various sparrows, starling, cardinal, woodpecker, nuthatch, chickadee, and others.

Non-game species seldom receive attention from the general public because they are not hunted and are often inconspicuous. However, they make up the larger portion of the wildlife resource and their involvement in the physical well being of the total environment is of no less importance than that of game species. Species densities of most non-game mammals and birds, amphibians and reptiles are relatively unknown. The Michigan Audubon Society Christmas bird counts and the U.S. Fish

and Wildlife cooperative breeding survey, 1970 to 1974, provide valuable data on winter and spring abundance of birds. Wildlife species known to occur in the Basin are listed in the USDA Technical Paper No. 5, *Amphibians, Reptiles, and Non-Game Birds and Mammals*. The densities for pheasant, white-tailed deer, and quail are shown in Figure 5-6.

The population trends for most of the major wildlife species are stable. However, projections of urban growth and more intensive and expanded agriculture may upset population stabilities as a result of habitat degradation or loss.

Limited information is available on population estimates of endangered, rare, or threatened species (with the exception of the sandhill crane). Known species are listed in the technical paper mentioned above.

The only endangered amphibian or reptile in the Basin is the Kirtland's water snake. An endangered species is one in danger of extinction through all or a significant part of its range. Some bird and mammal species that formerly occurred in the region have long since been extirpated locally.

There are 13 threatened species listed in the technical paper, including the copperbellied water snake, the barn owl, the Cooper's hawk, and the pine vole. A threatened species is one likely to become endangered within the forseeable future.

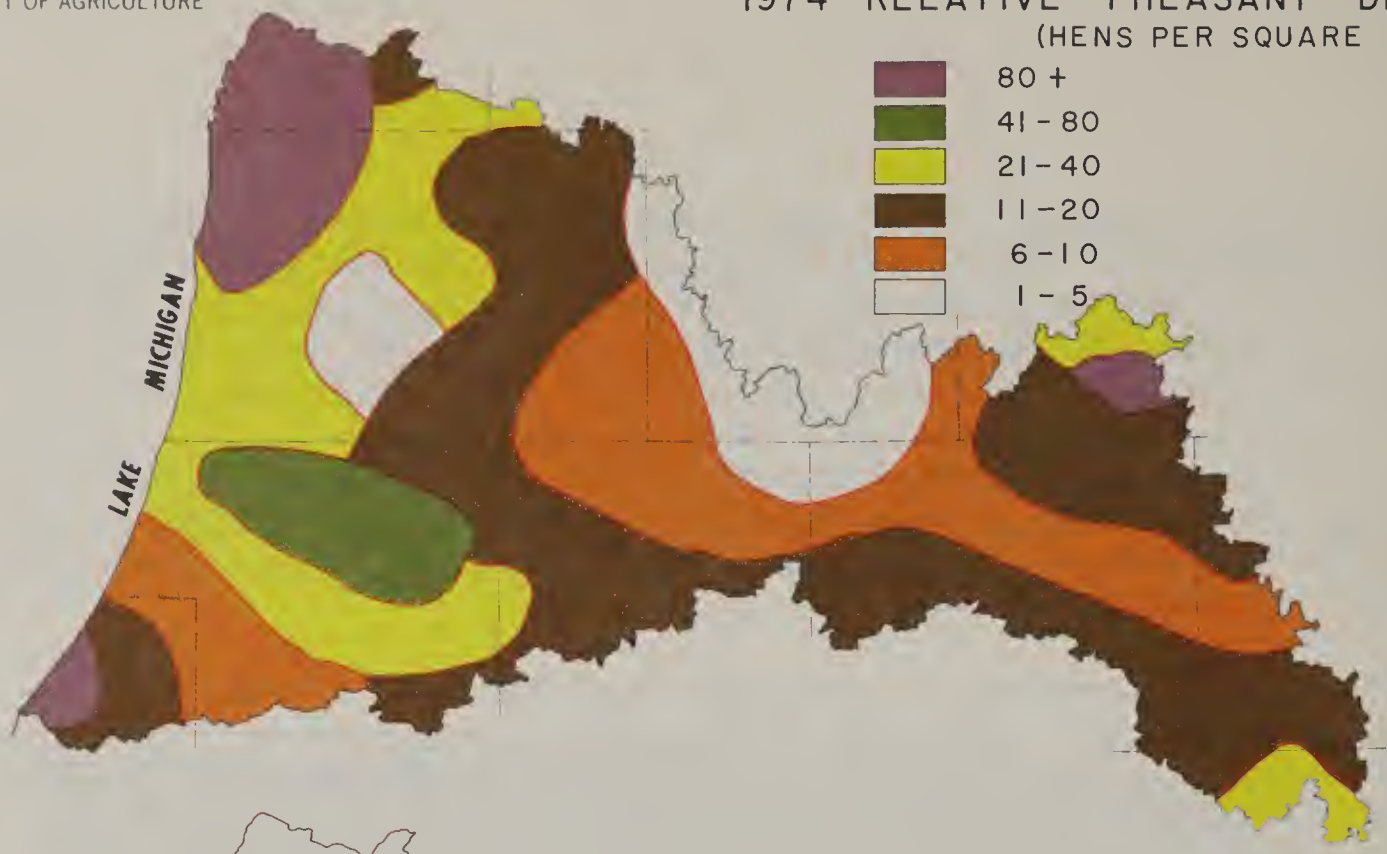
There are 49 known rare or scarce species in the Basin, including the badger, coyote, river otter, beaver, sandhill crane, upland sandpiper, the great blue heron, the prothonotary warbler, and the pileated woodpecker. Rare or scarce species are not known to be endangered or threatened but are uncommon and deserve continued monitoring of their status.

There is a wide variety of wildlife habitat throughout the Basin. Cropland provides valuable wildlife food. Grassland serves as nesting and escape cover. Forest land and wetland meet the total habitat requirements for many species. Urban land provides habitat for songbirds and squirrels.

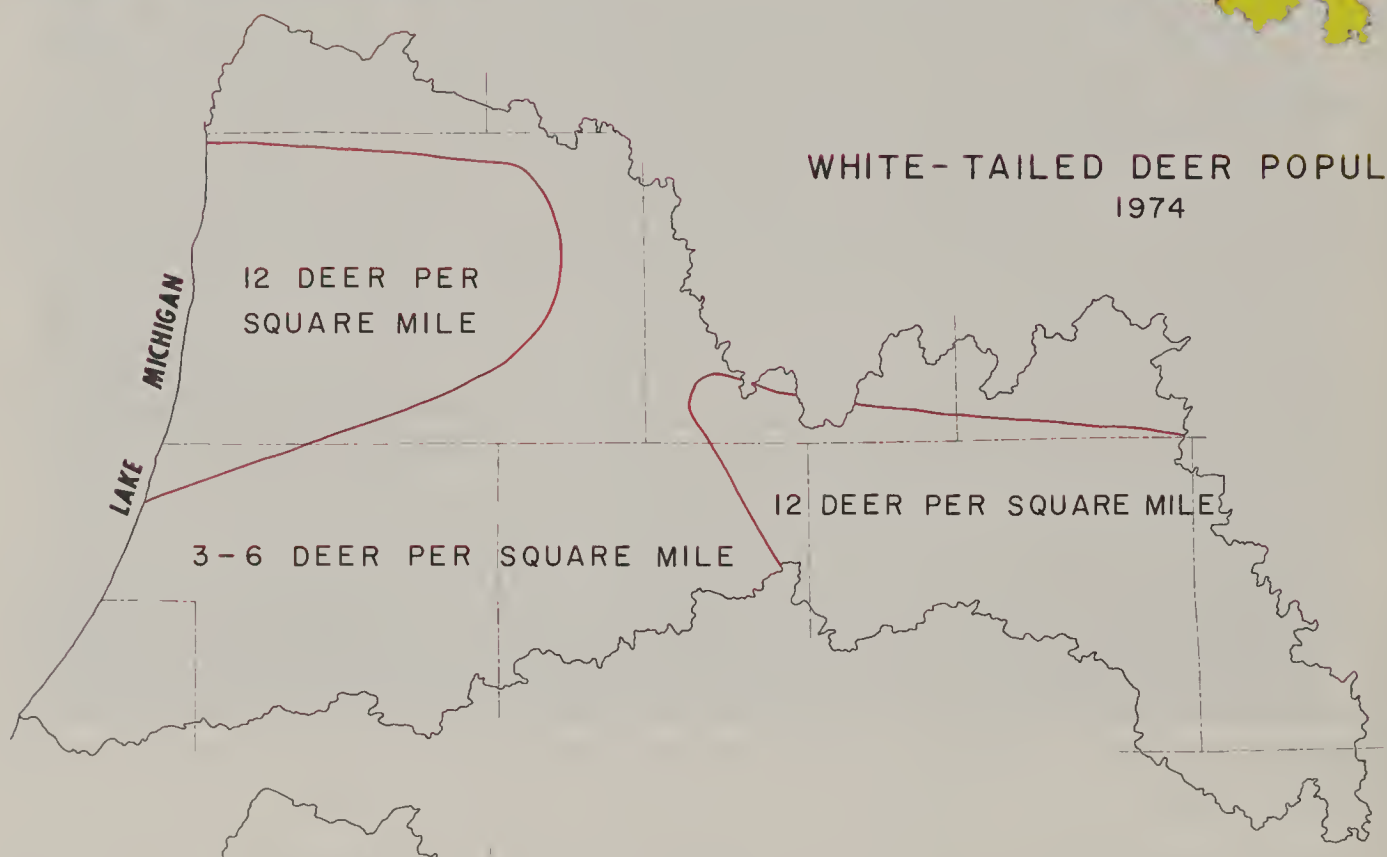
There are almost 122,000 acres of wetlands in the Basin (Table 5-5 and Figure 5-7). Wetlands provide food and cover for such species as waterfowl, mink, muskrat, amphibians, and reptiles. Many upland species use wetlands for escape, nesting, and winter cover. Marsh wetlands have the highest overall habitat value followed by open water, wooded, and shrub wetlands.

U. S. DEPARTMENT OF AGRICULTURE

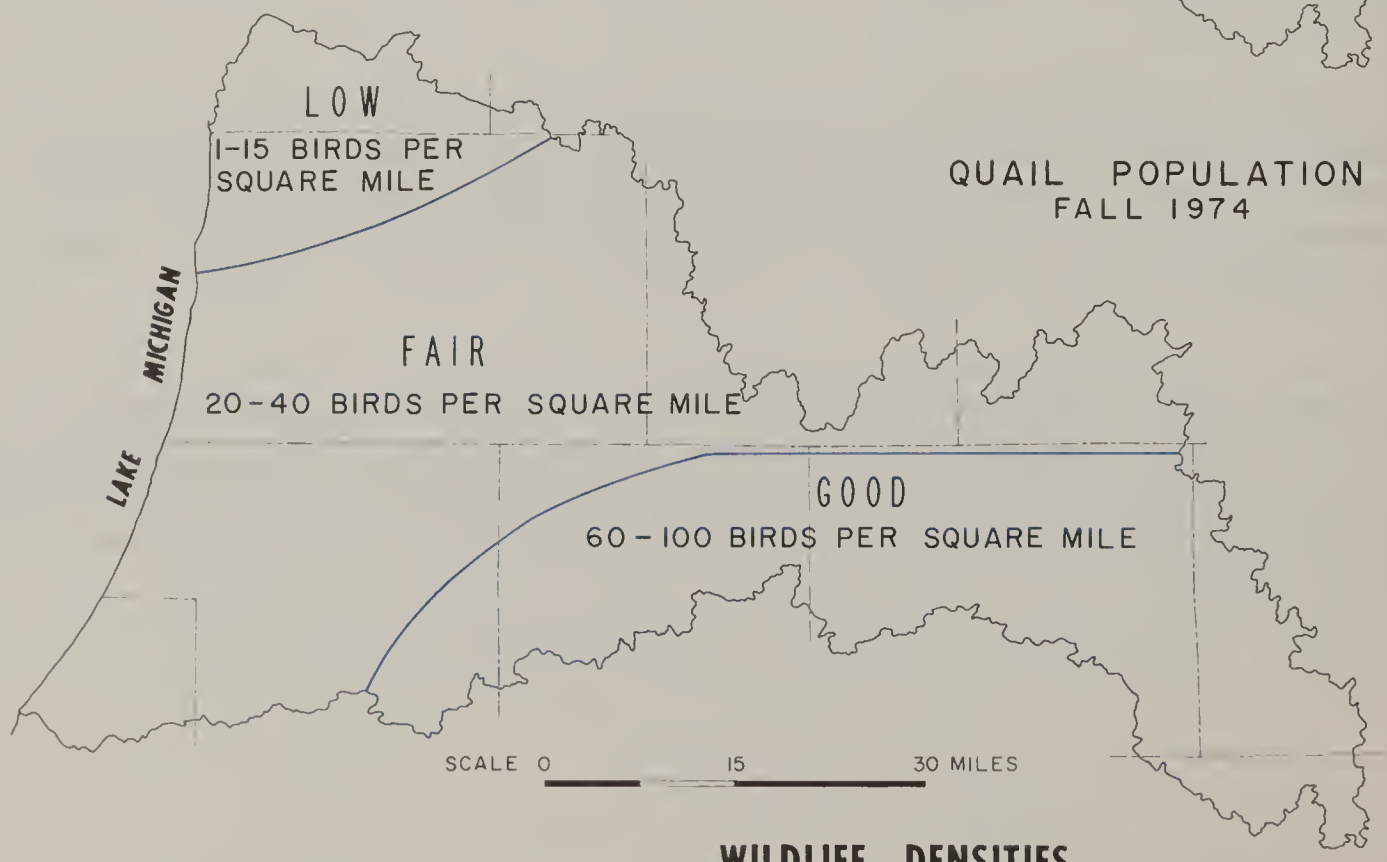
1974 - RELATIVE PHEASANT DENSITY
(HENS PER SQUARE MILE)



WHITE-TAILED DEER POPULATION
1974



QUAIL POPULATION
FALL 1974



N

WILDLIFE DENSITIES
KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN
MICHIGAN

FIGURE 5-6

SOURCE
FAMILY OF MAPS SCS DRWG NO 5,R-31,085 (1-75)
AND INFORMATION FROM FIELD TECHNICIANS
USDA - SCS - LINCOLN, NEBR 1976

12 - 22 - 76
5,S-35,949

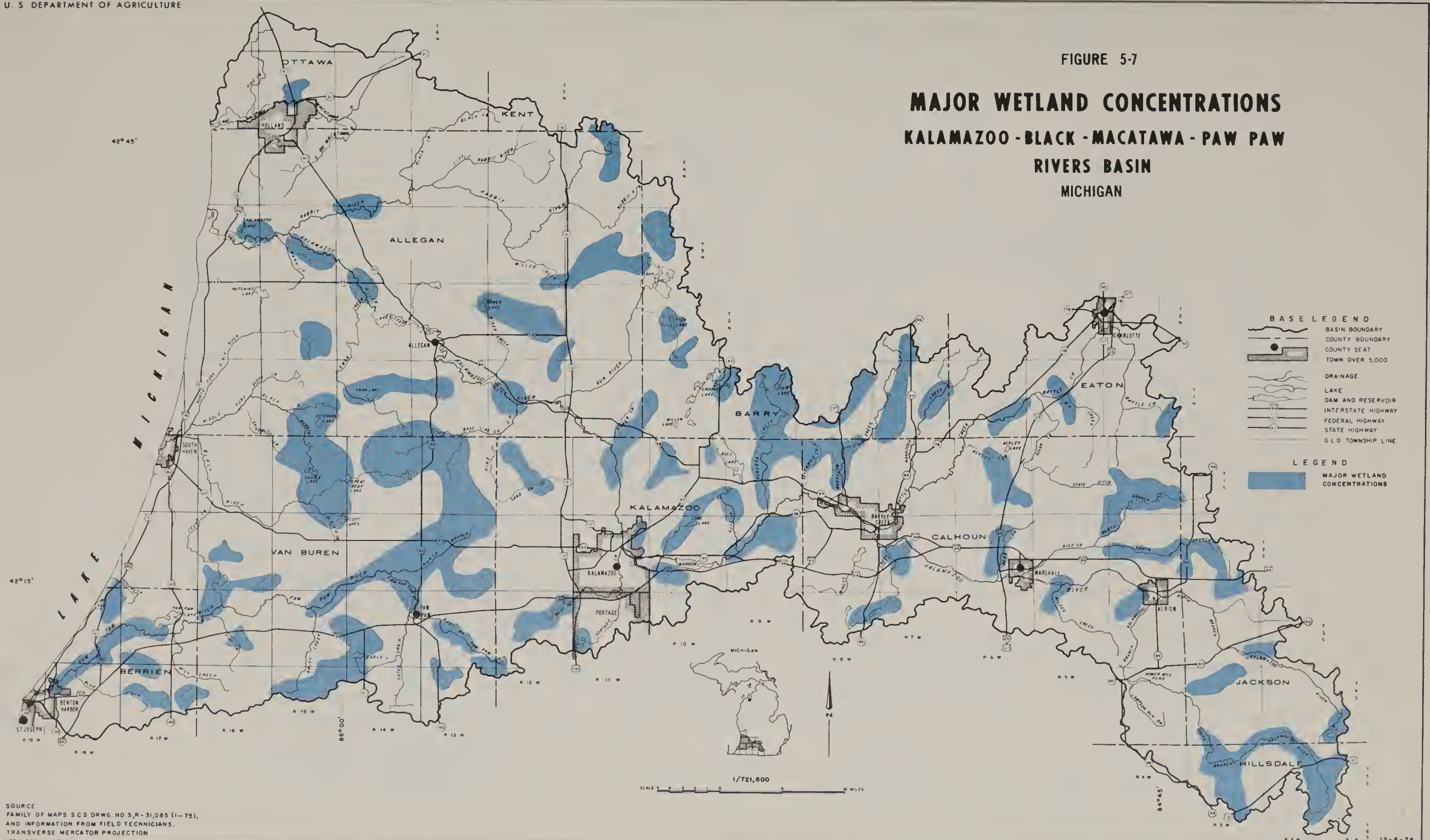
U. S DEPARTMENT OF AGRICULTURE

FIGURE 5-7

MAJOR WETLAND CONCENTRATIONS

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN



SOURCE
FAMILY OF MAPS SCS DRWG. NO 5,R-31,085 (1-75),
AND INFORMATION FROM FIELD TECHNICIANS.
TRANSVERSE MERCATOR PROJECTION
USDA-SCS-LINCOLN, NEBR. 1976

12-6-76
5,0-35,983

TABLE 5-5--SUMMARY OF WETLANDS

County	(Acres) Wetland Category				
	1/ Wooded	2/ Marsh	3/ Shrub	4/ Open Water	Total
Allegan	5,620	2,260	4,700	4,620	17,200
Barry	3,300	1,220	2,590	2,790	9,900
Berrien	5,880	320	1,100	800	8,100
Calhoun	13,310	4,580	3,490	420	21,800
Eaton	2,850	1,410	590	50	4,900
Hillsdale	3,520	710	660	210	5,100
Jackson	6,920	3,200	2,430	250	12,800
Kalamazoo	6,190	1,110	4,840	2,050	14,200
Ottawa	-	140	230	130	500
Van Buren	16,540	890	5,110	4,760	27,300
BASIN	64,130	15,840	25,740	16,090	121,800

1/ Wooded - Soil is waterlogged at least within a few inches of its surface during the growing season, and is often covered with as much as one foot of water. Dominant plants are elm, ash, willow and box elder.

2/ Marsh - Soil wetness varies from waterlogged to three feet or more. Dominant plants are sedges, bullrush, cattail and water lily.

3/ Shrub - Soil is usually waterlogged during growing season and is often covered with as much as six inches of water. Dominant plants are alder, willow, red-osier dogwood and buttonbush. Bogs, which are included in this category are characterized by leatherleaf, labrador tea and tamarack.

4/ Open Water - Water depths range from six inches to ten feet. Dominant plants are bulrush, cattail, water lily, spatterdock, water milfoils and pondweeds.

Urban land includes eight percent of the habitat. This habitat provides food, cover, and nesting areas primarily for songbirds and squirrels. In terms of total combined harvest, the Basin is one of the best hunting regions in the State. Success rates between counties have

varied due to habitat, weather conditions, an increase in hunting pressure, changes in wildlife quantity and quality, and an increase in posting of private land. Approximately 400,000 acres of public and private land are available for hunting.

Non-hunting recreational values of wildlife have never been quantified and are difficult to appraise. Some data are available for places where wildlife concentrate such as the Kellogg Bird Sanctuary, Kalamazoo Nature Center, and the Farm Unit of the Allegan State Game Area. As many as three to five thousand people may visit each of these areas during a weekend in the spring, fall and winter. State game and recreation areas are heavily used by the non-hunting public.

FISH RESOURCES

Major game fish in streams include such species as brook trout, brown trout, walleye, smallmouth and largemouth bass, northern pike, catfish and suckers. Carp and forage fish are common non-game species. The Chinook salmon, steelhead, and the brown trout represent the anadromous species. Anadromous fish are those which migrate from Lake Michigan up the rivers to spawn.

Rivers and streams provide habitat for both warmwater and coldwater species. According to the Michigan Department of Natural Resources, there are 328 miles of top quality warmwater streams that contain good populations of warmwater game fish (Figure 5-8 and Table 5-6). These streams have a relatively stable flow of good quality water that is comparatively free of silt and other pollutants.

There are 565 miles of second quality warmwater streams. These streams are capable of supporting good populations of warmwater game fish except for such factors as a lack of natural reproduction, over abundance of competing species, and presence of heavy silt load or other pollution. There are 58 miles of top quality coldwater streams. These streams contain good populations of trout and have a relatively stable flow of quality water.

There are 333 miles of second quality coldwater streams capable of supporting a trout fishery if certain fish management and pollution problems are corrected. The quality of the existing trout population is limited by such factors as lack of natural reproduction, overabundant competing species, and pollution.

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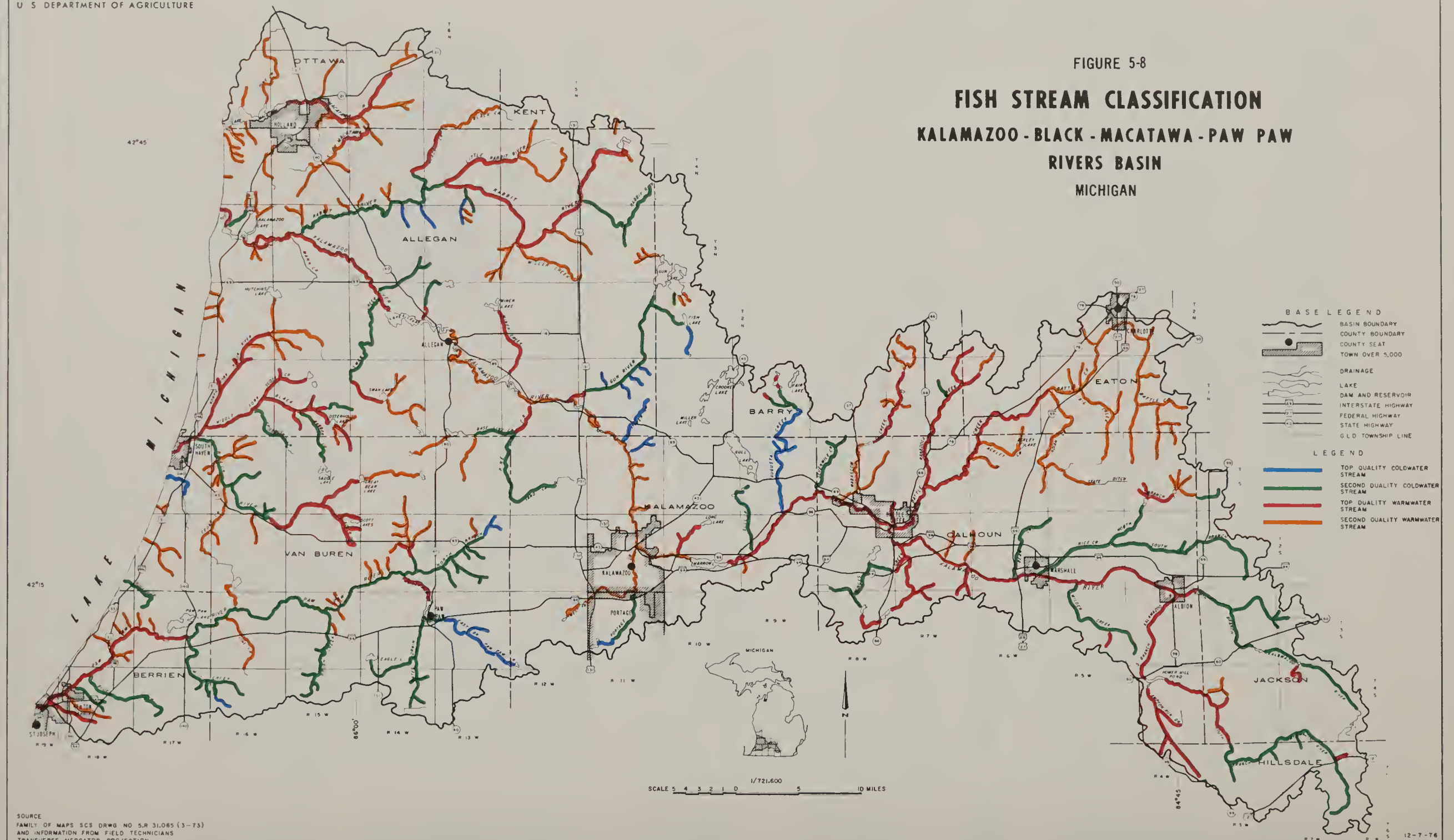
FIGURE 5-8

FISH STREAM CLASSIFICATION

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN



SOURCE
FAMILY OF MAPS SCS DRWG NO 5-R 31,065 (3-73)
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TRANSVERSE MERCATOR PROJECTION
USDA-SCS-LINCOLN, NEBR. 1976

12-7-76
5,0-35,986

TABLE 5-6--STREAM FISHERIES HABITAT

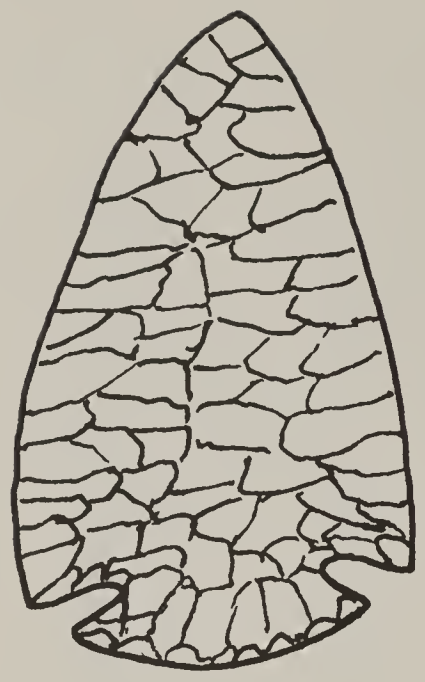
County	Stream Classification 1/ (Miles)				
	TQWW	SQWW	TQCW	SQCW	Total
Allegan	116	174	17	86	393
Barry	25	37	7	7	76
Berrien	15	34	-	36	85
Calhoun	93	77	-	55	225
Eaton	12	47	-	-	59
Hillsdale	1	-	-	10	11
Jackson	7	4	-	32	43
Kalamazoo	17	48	15	21	101
Ottawa	12	48	-	-	60
Van Buren	30	96	19	86	231
TOTAL	328	565	58	333	1,284

1/ Michigan Department of Natural Resources Stream Classification: TQWW--Top Quality Warmwater, SQWW--Second Quality Warmwater, TQCW--Top Quality Coldwater, SQCW--Second Quality Coldwater.

The Michigan Department of Natural Resources manages 16 lakes totaling 8,600 acres and 72 miles of streams by supplementing natural fish populations with fish produced in hatcheries or artificial marshes. Most of the managed waters are located west of Kalamazoo. There are 70 managed public access sites, including six stream access sites.

AESTHETIC AND CULTURAL RESOURCES

Frequently the most significant aesthetic and cultural resources are concentrated within and along the slopes of stream valleys. This occurs because these resources are now or at one time were water-related. Areas along the Kalamazoo, Battle Creek, Black, Paw Paw, and Rabbit Rivers and their tributaries possess an abundance of natural, scenic, and cultural resources.



Middle Woodland Point

The prehistoric record in southwest Michigan extends back approximately 11,000 years. Since that time, this region has been occupied by a succession of prehistoric people who have left their imprint upon the land. A large number of the archeological sites which document this prehistoric sequence have been destroyed in modern times, but many sites still remain and are an important, but too often neglected cultural resource for the people of Michigan.

A prehistoric archeological site is a place where aboriginal people carried out some activity which has left evidence in the ground, such as a camp-fire, a pattern of house posts, or a pit where corn was stored. Many sites are multi-component, that is, more than one prehistoric group lived at the location. A total of 241 archeological sites have been identified in the Basin to date (Table 5-7). More detailed information can be found in the USDA Technical Paper No. 7, *Inventory of Prehistoric Sites*. It has been estimated that this list represents 10 to 20 percent of the number of sites which exist.

TABLE 5-7--KNOWN ARCHEOLOGICAL SITES

	Cultural Stage									
County	Paleo Indian	Early Mid. Archaic	Late Archaic	Middle Woodland	Late Woodland	Unclassified Woodland	Aceramic	Historic Indian	Unknown	Total
Allegan	5	2	13	5	15	12	25	6	19	102
Barry	-	-	-	-	-	-	-	1	6	7
Berrien	2	1	3	-	-	5	7	-	8	26
Calhoun	4	-	5	1	-	6	3	1	1	21
Eaton	-	-	-	-	2	5	-	-	5	12
Hillsdale	1	1	2	1	3	1	-	-	-	9
Jackson	-	-	-	-	-	-	-	-	1	1
Kalamazoo	4	-	6	1	2	12	-	2	7	34
Ottawa	1	-	-	-	-	-	-	1	-	2
Van Buren	2	-	3	-	1	4	13	3	1	27
BASIN	19	4	32	8	23	45	48	14	48	241

USDA Technical Paper No. 8, *Inventory of Historic Sites*, identifies 112 numbered or marked historic sites. Sixty-one percent of the sites are located in Calhoun and Kalamazoo Counties (Table 5-8). The State of Michigan considers archeological and historical site designation through application to the State Historic Preservation Officer. Local designations are implemented by units of government at the county, township and municipal level. Fifty-four sites have the potential for historic site designation at either the local or State level.

TABLE 5-8--HISTORIC SITES

County	Homes	Gov't and Business	Education - Schools	Church	Other	Total
Allegan	2	1	-	4	3	10
Barry	-	-	-	-	3	3
Berrien	2	-	-	-	5	7
Calhoun	12	9	5	4	12	42
Eaton	2	2	1	1	1	7
Hillsdale	1	-	-	-	-	1
Jackson	-	-	1	-	-	1
Kalamazoo	3	5	6	-	12	26
Ottawa	-	-	1	5	4	10
Van Buren	-	3	1	-	1	5
BASIN	22	20	15	14	41	112

PLANT RESOURCES

As a result of the action of the Wisconsin Glacier, the region is topographically diverse, possessing hills, valleys, plains, ponds, lakes, and a variety of soil types that provide excellent habitats for a vast number of plants. In addition, the influence of nearby Lake Michigan moderates the climate of this region so that a number of plant species thrive or survive that otherwise might not do so.

Seven basic or major types of native plant communities are recognized (Table 5-9). While each of these is considered as a distinct community, many ecotones, or gradual transition zones, exist between these communities. These communities are used to describe the best habitats of the dominant species. Some of the dominant species have a fairly wide tolerance of habitats and, therefore, may be prevalent in more than one habitat. All of these species are considered abundant where they occur.

TABLE 5-9--NATIVE PLANT COMMUNITIES

Community	Characteristics
Dry Southern Hardwood Forest	Forests of dry upland sites with bur oak, black oak or white oak dominating.
Mesic Southern Hardwood Forest	Forests that occur in moist soils and are dominated by beech and sugar maple.
Wet Lowland Forest	Forests characterized by willow or cottonwood, or silver maple, or ash.
Sphagnum Bogs	Open, treeless wet areas dominated by heath-like shrubs and sphagnum moss.
Grassland-Savanna Complex	Includes the combination of prairies, sedge meadows and savannas. Characterized as treeless or with scattered trees and dominated by grasses or sedges either wet or dry.
Marshes and Emergent Aquatic Communities	Treeless areas in which the water table is above the soil surface during most of the growing season.
Submerged Aquatic Communities	Dominant plant species are below or on the water surface. These communities are essentially lakes and ponds.

Approximately 46 dominant herbaceous and shrubby plant species are found in the Basin as indicated in the USDA Technical Paper No. 6, *Inventory of Rare, Endangered, Scarce and Other Herbaceous and Shrubby Plant Species*. It has been estimated that as many as 10 percent of the higher plants in the United States are threatened with extinction. This is largely due to encroachment upon or destruction of plant habitats by increased human needs. In addition, many of the showier plant species are threatened by picking.

TRAILING ARBUTUS.—*Epigæa repens.*

There are 22 identified sites which contain one or more rare plant species (Figure 5-9 and Table 5-10). These are located in five

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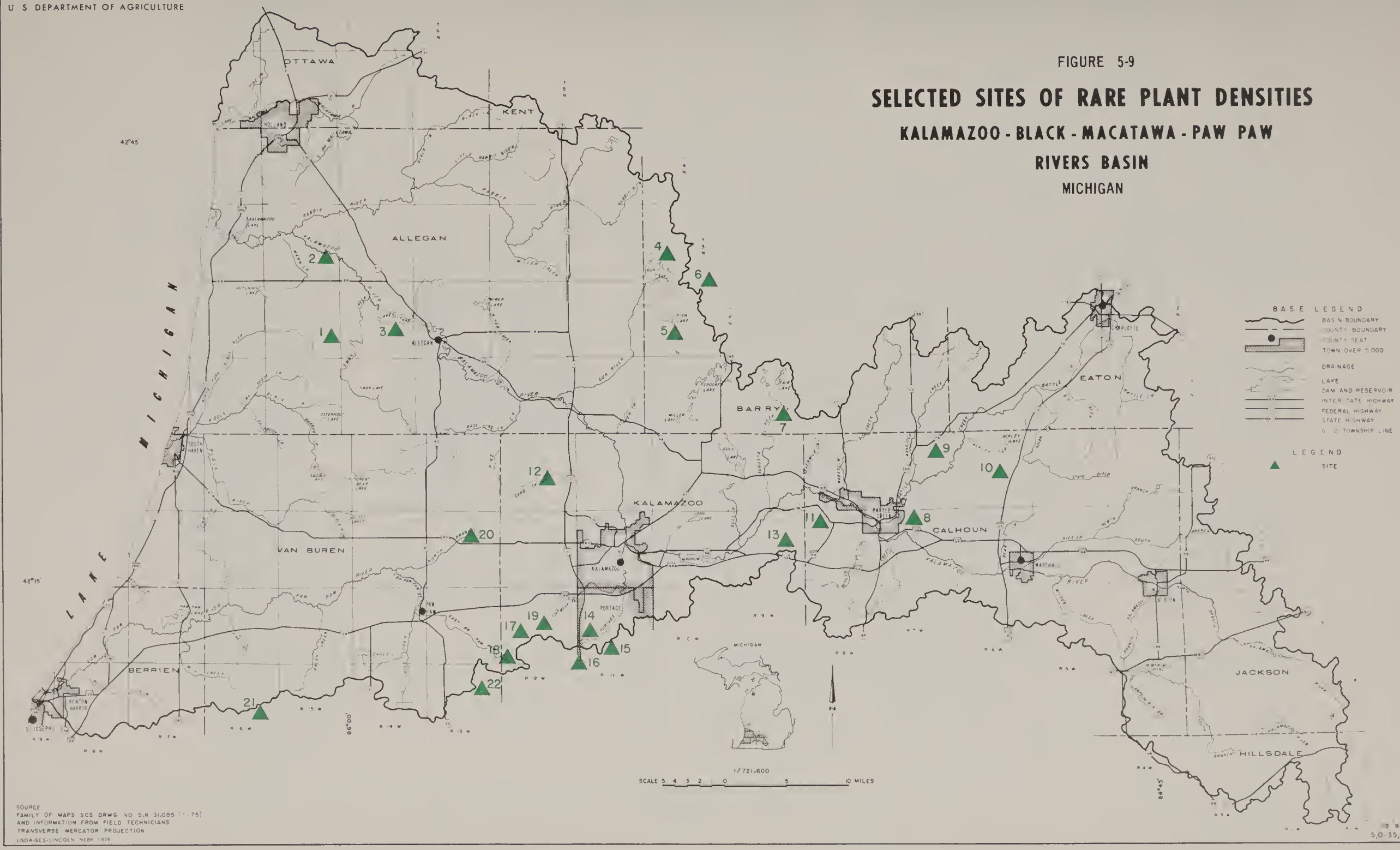
FIGURE 5-9

SELECTED SITES OF RARE PLANT DENSITIES

KALAMAZOO - BLACK - MACATAWA - PAW PAW RIVERS BASIN

MICHIGAN



BASE LEGEND

- BASIN BOUNDARY
- COUNTY BOUNDARY
- COUNTY SEAT
- TOWN OVER 5,000
- DRAINAGE
- LAKE
- DAM AND RESERVOIR
- INTERSTATE HIGHWAY
- FEDERAL HIGHWAY
- STATE HIGHWAY
- G. O. TOWNSHIP LINE

LEGEND

- ▲ SITE

SOURCE
FAMILY OF MAPS SCS DRWG NO 5,R 31,085 (1-75)
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TRANSVERSE MERCATOR PROJECTION

USDA-SCS-LINCOLN, NEBR 1976

5,0-35,99

TABLE 5-10--SELECTED SITES OF RARE PLANT DENSITIES

1.	Ely, Little Tom & Crooked Lake Area	Allegan Co., Clyde Twp. S-26+36	Bog plants, coastal plains species	State
2.	Fennville Bog	Allegan Co., Manlius Twp. S-26	Native orchids, other bog species	Private
3.	Prairie Areas	Allegan Valley Twp. S-22, 23, 24	Sandy prairie species	Private
4.	Yankee Springs Rec. Area	Barry Co., Yankee Springs Twp.	Many rare and unusual species	State
5.	Fish Lake Area	Barry Co., Orangeville Twp. S-21	Marly marsh and moist woods species	State
6.	Daggett Lake Area*	Barry Co., Orangeville Twp. S-1	Coastal plains species	State
7.	Purdy Lake Bog	Barry Co., Barry Twp. S-36	Sphagnum bog species	Private
8.	Ott Preserve	Calhoun Co., Emmett Township	Bog species	Albion College
9.	Pennefield Bog	Calhoun Co., Pennefield Twp. S-11	Native orchids and other bog species	Michigan Nature Association
10.	Baker Sanctuary	Calhoun Co., Convis Twp. S-22	Native orchids and other bog species	Michigan Audubon Society
11.	Calhoun Creek Prairie	Calhoun Co., Bedford Twp. S-33,34	Upland and wet prairie species	Private
12.	Mud Lakes (Veley Lake) Region	Kalamazoo Co., Alamo Twp. S-22,23	Bog and marsh species	Private
13.	Ft. Custer Area	Kalamazoo Co., Charleston Twp.	Dry oak woodlands, grasslands	Federal
14.	Gourdneck Game Area	Kalamazoo Co., Portage Twp. S-19,20	Upland-dry woods and bog species	State and Private
15.	Portage Bog*	Kalamazoo Co., Portage Twp. S-28	Native orchids and other bog species	Private
16.	Sugarloaf Lake Area*	Kalamazoo Co., Portage Twp. S-30,31	Native orchids and ferns	Private
17.	Crooked, Eagle, Pretty Pine Island Lakes Area	Kalamazoo Co., Texas Township	Aquatic, wet and dry upland areas	Private
18.	Paw Paw Lake Area	Kalamazoo Co., Texas Twp. S-31,32	Sandy-shored lake area with swamps and bog species	Private
19.	West Fork Portage Creek	Kalamazoo Co., Texas Twp. S-11	Upland woods, marsh, swamp and tamarak bog species	Private, City of Kalamazoo & Kalamazoo Valley Community College
20.	Wolf Lake Area	Van Buren Co.,Almena Twp. S-11,14	Club mosses	State and Private
21.	Keeler Lake*	Van Buren Co.,Keeler Twp. S-23	Rare plant species	Private
22.	Bankson Lake*	Van Buren Co.,Porter Twp. S-14	Sandy shore and bog species	Private

*Located just outside the Rivers Basin boundary.

different counties. Five of the sites are just outside the Basin boundaries, but worthy of mention. Not all of these sites are in ownership which would insure protection and proper management.

NATURAL RESOURCE USE

Population and employment characteristics can indicate the nature and level of an area's economic activity, and hence how its resources are being used. Population in the 10 counties comprising the Basin was 1,045,280 in 1970. The most populous county was Kalamazoo with 19.3 percent of the total. Berrien and Jackson Counties accounted for an additional 29.3 percent. The estimated population for the Basin area itself was 556,000, some 10 percent higher than the 1960 level. This growth rate was somewhat less than the 13.5 percent experienced for the state.

The Basin is urbanizing at a greater rate than the state even though two of its major cities, Benton Harbor and Battle Creek, lost significant numbers between 1960 and 1970. In 1970, 46 percent of the urban populace lived in the four largest cities--Benton Harbor, Battle Creek, Kalamazoo, and Holland. The largest urban concentration is in the Kalamazoo-Portage metropolitan area which had 146,686 persons in 1970. Several large metropolitan areas, including Grand Rapids, Lansing, and Jackson, are outside of the Basin but have a significant effect on the area economy and provide educational and cultural opportunities.

In view of the above, rural numbers are obviously falling. In particular, between 1960 and 1970 rural farm population for the 10-county area dropped 11.4 percent to 89,036 persons. This is considerably less than the state's 36.7 percent decrease. It should be noted that while this level is only 8.5 percent of the 10-county total, it represents 32.1 percent of Michigan's farm population.

Labor force employment can provide a good indicator of an area's economic health and structure. When a large percentage of the labor force is employed, output is near capacity. High employment indicates not only a desire for goods and services, but also the ability obtain them. Civilian employment for the 10-county area rose 19.6 percent between 1960 and 1970 to 395,200. This is nearly identical to the 19.3 percent increase for Michigan. The largest gains were experienced in Eaton County, 45.3 percent, and Ottawa County, 37.3 percent. Calhoun County had the least growth with 6.8 percent.

Statewide unemployment fell from 6.9 percent of the civilian labor force to 5.9 percent between 1960 and 1970 (Figure 5-10). While that for the Basin rose from 4.8 to 5.2 percent, it was still below the state average.

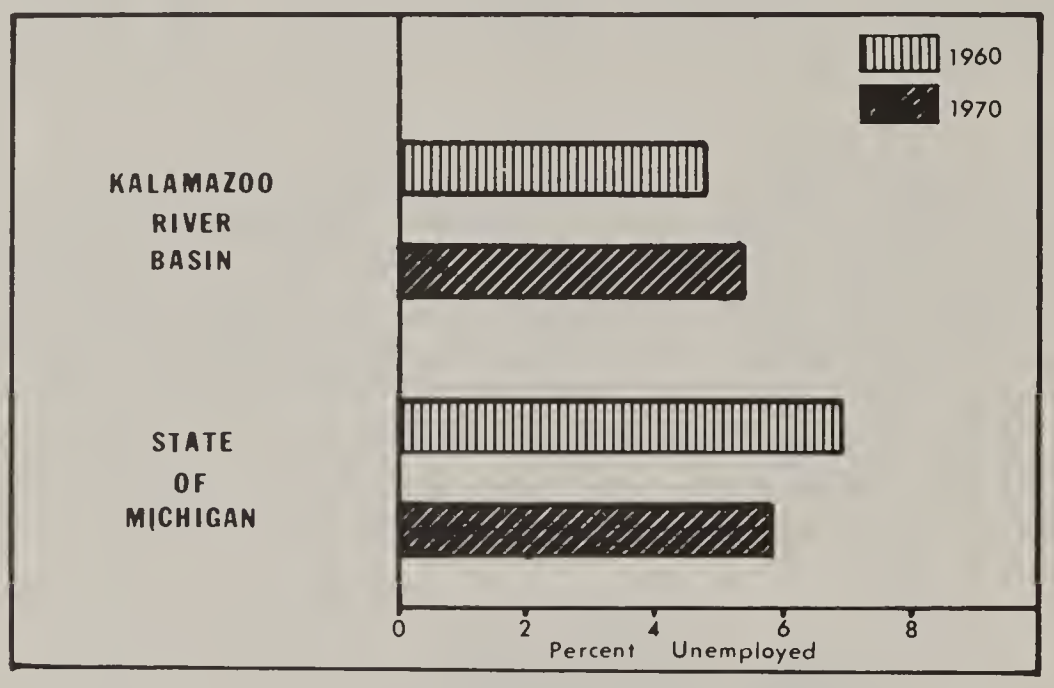

FIGURE 5-10--PERCENT UNEMPLOYED OF CIVILIAN LABOR FORCE

Figure 5-11 compares labor force employment for six sectors of the economy in the 10-county area. Manufacturing and services provide the most employment with 68.3 percent. The number of workers rose in all sectors except the agricultural, forestry and fisheries sector, where there was a significant decline. The greatest expansions occurred in the trade and services sectors.

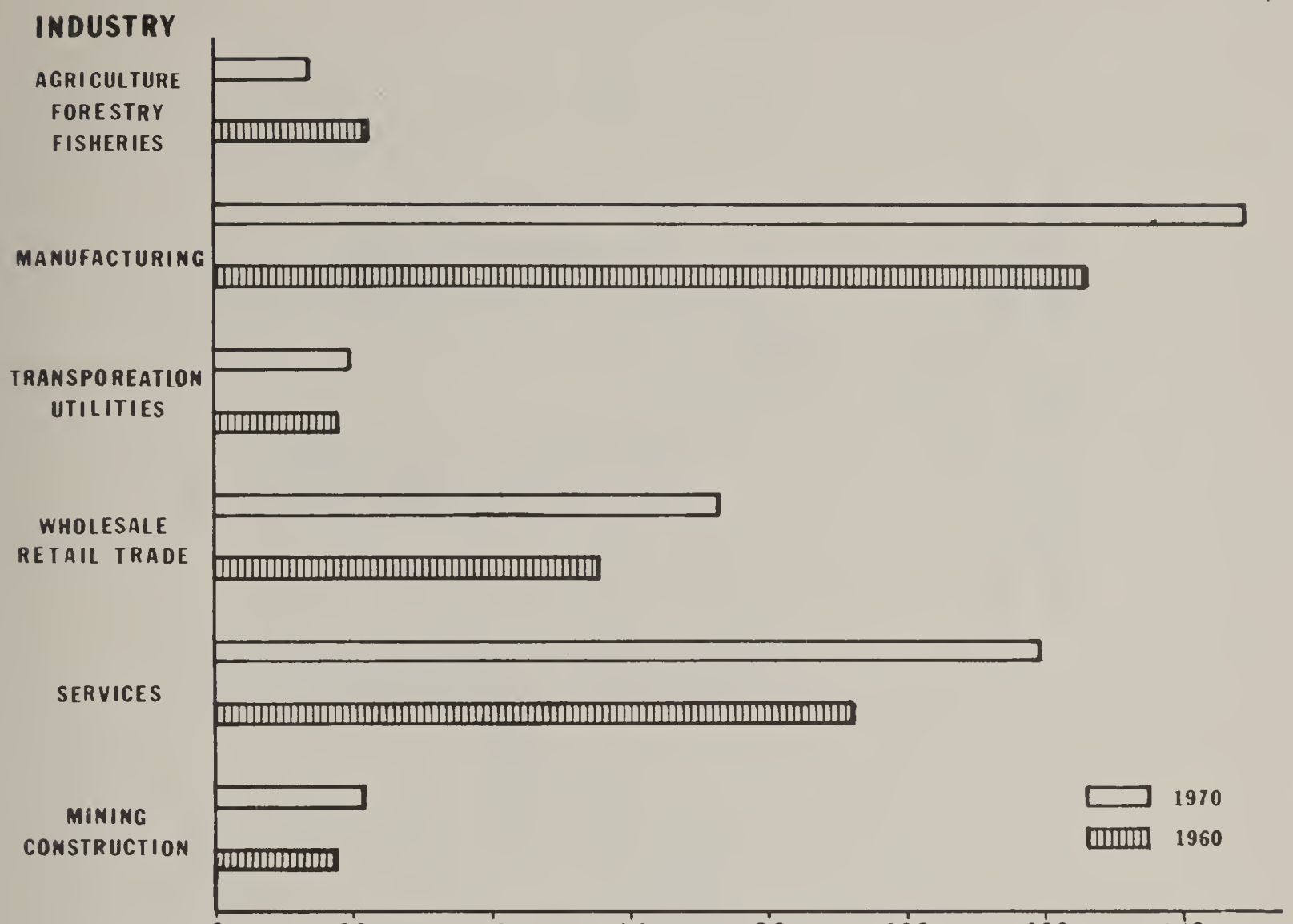

FIGURE 5-11--CIVILIAN LABOR FORCE EMPLOYMENT
(10 COUNTY AREA)

Forestry employment is spread among three industries; sawmills, veneer mills, and a pulp mill (Figure 5-12). Employment is highest at the pulp mill with approximately 230 employees and a payroll valued at about $2.6 million annually. Three veneer mills collectively employ approximately 150 persons with an estimated annual payroll of $668,000. Fifteen sawmills collectively employ approximately 49 persons with an annual payroll of about $124,000.

LAND USE

Distribution of land in the Basin by major use shows cropland and pasture account for the greatest share, 57.0 percent (Table 5-11 and Figure 5-13). Forests also use a major share with 21.1 percent. Within

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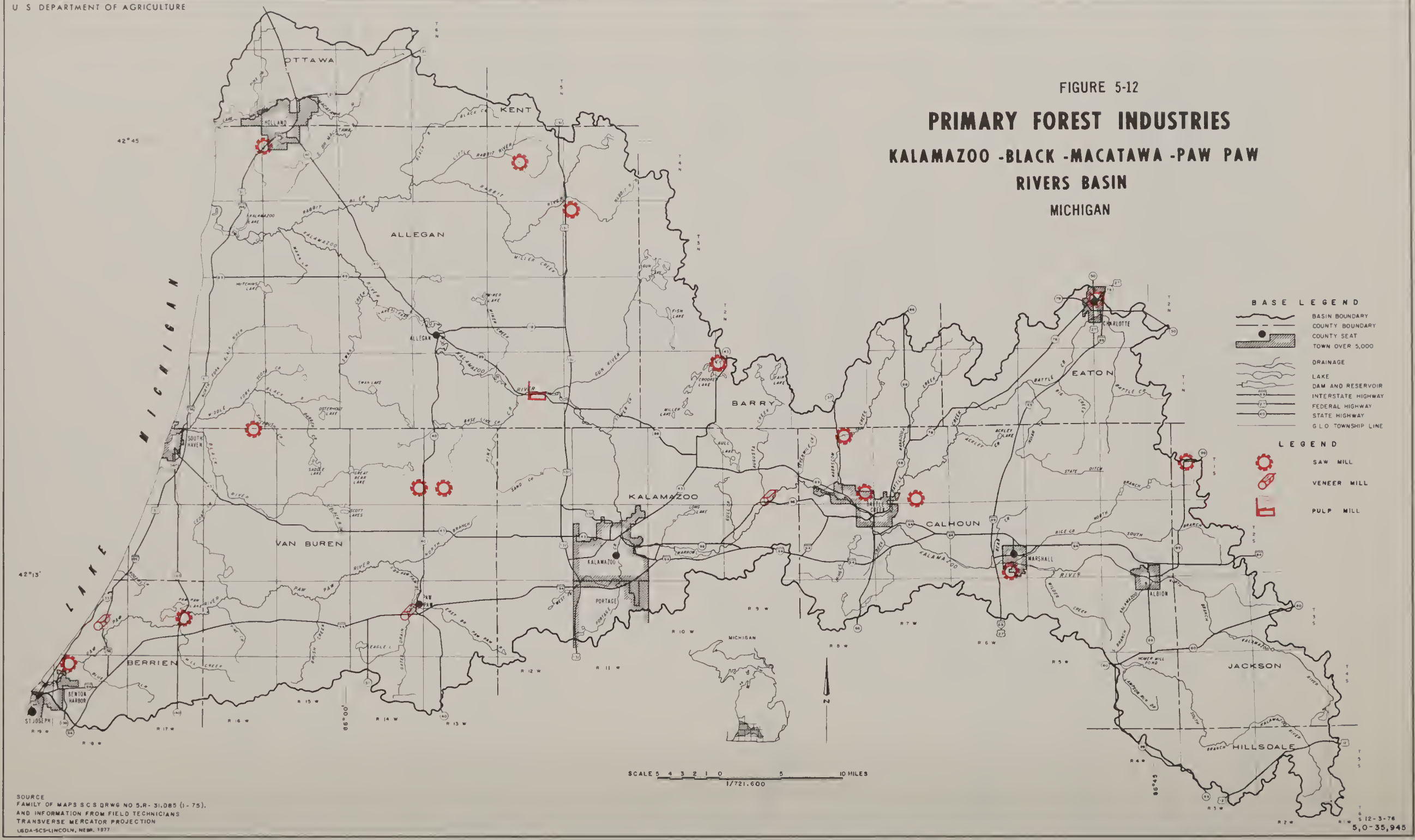
FIGURE 5-12

PRIMARY FOREST INDUSTRIES

KALAMAZOO -BLACK -MACATAWA -PAW PAW RIVERS BASIN

MICHIGAN



BASE LEGEND

- BASIN BOUNDARY
- COUNTY BOUNDARY
- COUNTY SEAT
- TOWN OVER 5,000
- DRAINAGE
- LAKE
- DAM AND RESERVOIR
- INTERSTATE HIGHWAY
- FEDERAL HIGHWAY
- STATE HIGHWAY
- G L O TOWNSHIP LINE

LEGEND

- SAW MILL
- VENEER MILL
- PULP MILL

SOURCE
FAMILY OF MAPS S C S DRWG NO 5.R- 31,085 (1 - 75).
AND INFORMATION FROM FIELD TECHNICIANS
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USDA-SCS-LINCOLN, NEBR. 1977

12-3-76

5,0-35,945

TABLE 5-11--1973 LAND INVENTORY

County	Cropland 1/	Pasture	Forest 2/	Wetland	Water	Urban	Other	Total 3/
Allegan	298,954	25,913	146,502	11,580	9,600	19,720	24,900	537,169
Barry	44,782	6,962	31,819	6,595	6,880	4,800	15,300	117,138
Berrien	40,049	1,724	12,809	2,210	1,200	11,400	3,611	73,003
Calhoun	178,538	12,439	50,106	8,510	4,342	27,027	31,612	312,574
Eaton	44,333	-	12,254	2,080	880	4,870	19,753	84,170
Hillsdale	27,410	1,704	11,205	1,580	400	1,134	1,823	45,256
Jackson	44,207	4,993	12,262	5,895	1,160	4,408	27,167	100,542
Kalamazoo	93,535	4,070	31,518	7,985	6,160	51,080	23,930	218,278
Kent	4,000	1,400	1,040	-	-	200	528	7,168
Ottawa	43,719	7,639	11,840	525	2,070	11,440	5,124	82,357
Van Buren	186,305	20,325	83,528	10,735	6,440	13,200	23,275	343,808
BASIN	1,005,832	87,169	404,883	57,695	39,582	149,279	177,023	1,921,463

1/ Includes active and idle cropland.
2/ Includes 64,100 acres of forested wetlands.
3/ All figures are acres.

the cropland category, some 275,000 acres are classified as open or idle. Nearly 200,000 acres of this has not been cropped for 12 years or more and hence might require substantial clearing costs to prepare it for cultivation. On the other hand, this land could be put to non-cropland uses. There are about 58,000 acres of wetland; to this can be added some 64,000 acres of wet forest land which can also be classified as type IV and VII wetland according to U.S. Fish and Wildlife Circular 39, *Wetlands of the United States*. Although less than eight percent is identified as urban, urban development normally affects a far greater area. Finally, much of the land is also used for purposes such as outdoor recreation and aesthetic enjoyment.

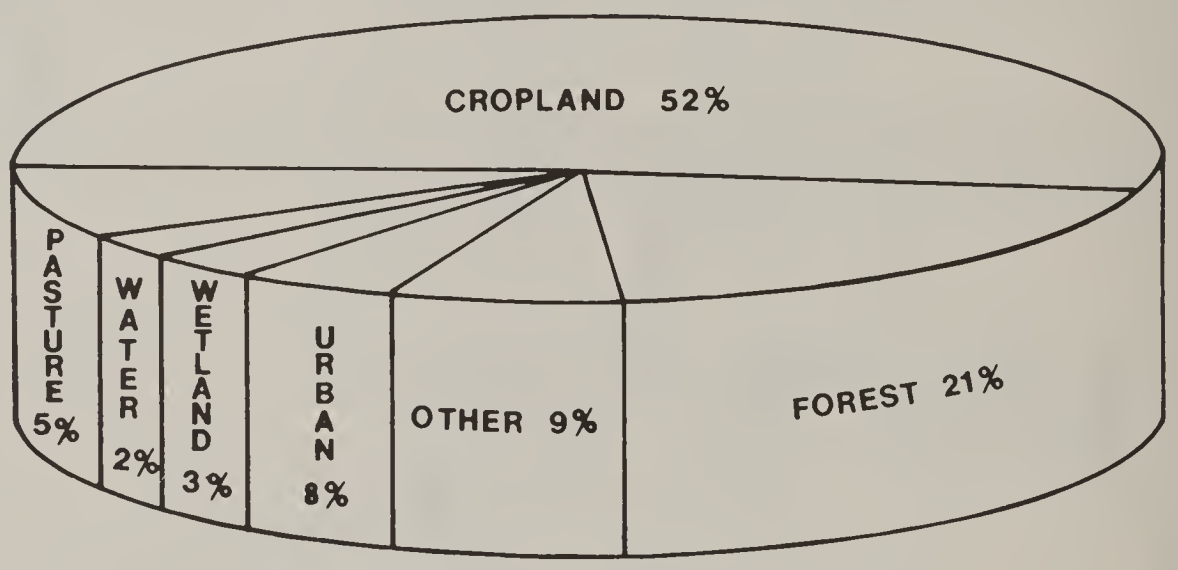

FIGURE 5-13--LAND USE IN THE BASIN

CROP AND PASTURE

Commercial agriculture is relatively more important in the 10-county region than in the state. The region accounted for only 11 percent of Michigan's acreage but 21 percent of its commercial farm land in 1974, and 23 percent of the market value of the state's agricultural products. Furthermore, in 1974, over two-fifths of the region was commercially farmed compared to one-fourth of the state. Between 1959 and 1974, the number of commercial farms--farms with annual sales greater than $2,500--has been falling; average farm size has been growing in both areas at nearly the same rate (Figure 5-14). Thus, in 1969, there were 9,876 commercial farms in the region with an average size of 177 acres, while in 1959 there were 13,014 farms averaging 168 acres in size. This trend continued between 1969 and 1974 with a further decline to 9,038 farms and an increase in average size to 181 acres. Off-farm employment for farm operators has also been rising in both areas; in 1969, slightly more than half the farm operators were so employed.

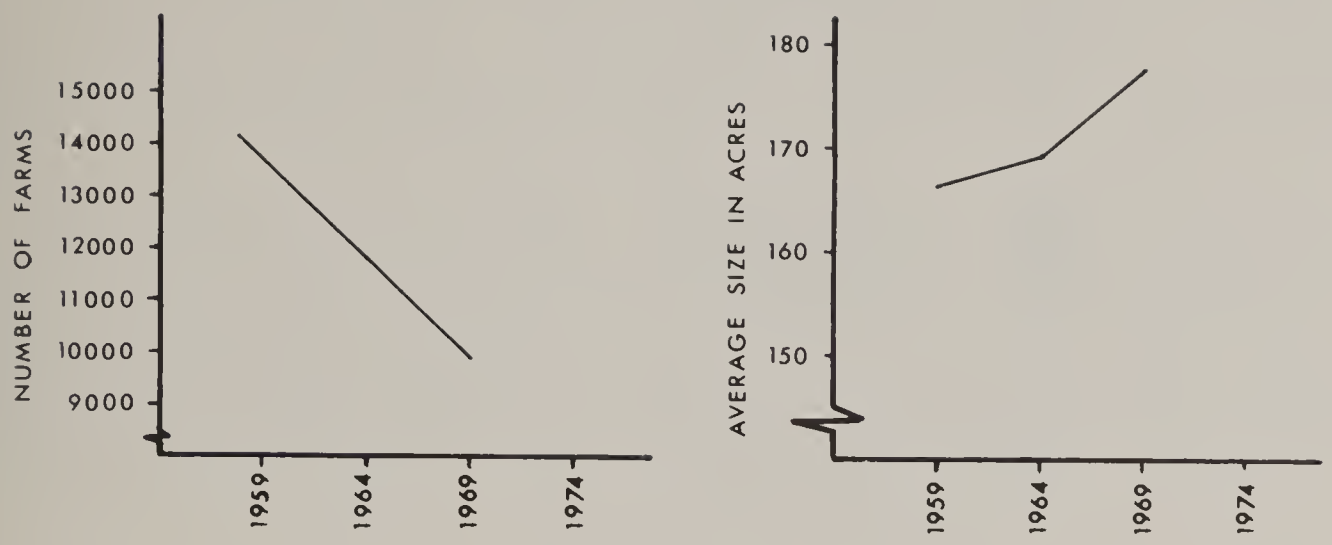

FIGURE 5-14--NUMBER AND SIZE OF COMMERCIAL FARMS
(10-COUNTY REGION)

Tables 5-12 and 5-13 show acreage and production trends for both the 10-county region and the state. Data is not directly available for the Basin. Although corn acreage diminished by more than one-fourth in both areas, it remains the most extensive crop. Due to higher yields, however, production rose slightly in both areas. Corn is particularly important in the eastern counties of Calhoun and Hillsdale.

TABLE 5-12 --CROPLAND HARVESTED

Crop	10-County Region			Michigan		
	1959	1969	1974	1959	1969	1974
	1,000 acres					
Corn, all purposes	513.1	379.5	614.9	1,668.6	1,190.0	2,338.5
Soybeans	19.3	57.5	68.6	224.5	472.2	556.0
Wheat	223.9	115.1	154.3	1,075.9	540.8	795.9
Oats, barley, rye	173.4	81.2	45.0	1,012.1	516.9	307.4
Hay	311.3	241.4	238.8	1,883.2	1,375.5	1,345.5
Orchards	87.7	70.2	70.4	201.2	191.0	166.2
Vegetables	32.5	27.7	34.6	108.6	100.7	105.5

SOURCE: U.S. Census of Agriculture

TABLE 5-13--PRODUCTION OF MAJOR CROPS

Crop	Unit	10-County Region			Michigan		
		1959	1969	1974	1959	1969	1974
		1,000's					
Corn for grain	bu.	22,673.6	23,238.1	26,151.0	88,560.1	92,988.2	110,383.1
Soybeans	bu.	404.8	1,237.8	1,222.4	5,417.1	11,054.0	11,727.4
Wheat	bu.	6,858.0	4,302.6	5,246.3	34,597.3	21,102.1	31,316.5
Hay	tn.	667.8	604.8	528.1	3,165.3	3,478.5	2,910.7
Oats	bu.	5,878.4	3,604.2	2,171.0	36,282.9	22,814.6	16,310.1

SOURCE: U.S. Census Agriculture

Wheat and other small grains acreage fell by nearly one-half in both areas. The 10-county region, however, posted a much larger decline in production, 59 percent, than did the state which had a 39 percent decline. In 1973, Calhoun and Kalamazoo Counties were the major producers of oats; Eaton, Kalamazoo, and Calhoun were the leaders in wheat.

Hay tonnage fell 9 percent in the 10-county region while rising 10 percent across the state between 1959 and 1969. Soybean acreage and production increased rapidly from initially low levels over the 10-year period. The greatest percentage increases took place in the 10-county region but the crop remains insignificant in terms of land occupied. Hillsdale and Berrien Counties account for three-fifths of production in the 10-county region.

Data is not directly available for the Basin alone. Acreage estimates, however, suggest that the Basin accounted for 44 percent of the 10 counties' corn acreage during 1970-73, 26 percent of soybeans, 41 percent of oats and wheat, 47 percent of hay, and 66 percent of orchard acreage.

Whereas the counties in the southeastern end of the Basin, Calhoun, Eaton, Hillsdale, and Kalamazoo, produce the major share of row crops and small grains, those in the west, Allegan, Berrien, Ottawa, and Van Buren--and also Kalamazoo--produce significant quantities of tree fruits, grapes, and vegetables. According to the Michigan Crop Reporting Service, in 1973 these five western counties accounted for 97 percent of the state's grape acreage, 90 percent of the blueberry acreage, 61 percent of the pear acreage, 53 percent of the strawberry acreage, 42 percent of the prune and plum acreage, and 39 percent of the apple acreage. The ranking of some individual counties is as follows:

Allegan - Second in cauliflower, onion, and pear acreage; third in blueberry acreage.

Berrien - First in cantaloupe, prune, plum, pear, raspberry, strawberry, and tomato acreage; second in all vegetable sales, and in apple and grape acreage; third in asparagus acreage; fourth in blueberry acreage.

Ottawa - Second in blueberry acreage; third in onion acreage; fourth in all vegetable sales.

Van Buren - First in asparagus, blueberry, and grape acreage; second in cantaloupe, cucumber, raspberry, snapbean, and strawberry acreage; third in apple, pear, prune, plum acreage; fifth in all vegetable sales.

Farm sales and related income in the 10 counties totaled $217 million in 1969. At 24.6 percent of the state total, it is only slightly below the 24.4 percent of 1959. Agricultural sales (crops including hay, forest products, and livestock, and poultry, and their products) provided 94.2 percent of the total. Government farm programs accounted for 4.5 percent. The remainder was from recreational and other services.

In 1959, the market value of agricultural sales was nearly evenly divided between crop sales and livestock sales. Over the next decade, livestock sales grew steadily in importance, and in 1969 the portion of sales derived from livestock rose to 62 percent. The 1974 census, however, indicates that this percentage has declined to 52 percent.

A comparison of sales between 1959 and 1974 suggests little change in numbers of cattle-calves and hogs-pigs in the 10-county region, but considerably fewer milk cows, broilers, and sheep-lambs (Table 5-14). Allegan, Calhoun, and Jackson Counties have the largest inventories of cattle-calves and hogs-pigs. Most of the region's sheep-lamb inventory is located in the eastern end of the 10-county region, especially Jackson County, which accounted for one-fourth. In 1974 Ottawa County accounted for 84 percent of all broiler sales.

TABLE 5-14--LIVESTOCK AND POULTRY SALES

Sales	10-County Region			Michigan		
	1959	1969	1974	1959	1969	1974
	1,000's of Animals					
Cattle & calves	145.9	155.8	139.9	743.3	760.0	644.9
Hogs and pigs	345.3	381.7	353.6	1,066.7	1,109.6	996.9
Sheep and lambs	54.9	48.1	28.4	287.3	197.3	125.4
Broilers	-	637.7	204.3	2,670.7	737.7	324.3
Milk Cows (no.)	114.7	80.2	77.1	612.2	413.9	204.3

SOURCE: U.S. Census of Agriculture

FOREST

There are approximately 404,900 acres of forest land in the Basin. Presently, however, much of the standing timber in the Basin is unmarketable, not of suitable size, quality, or desired species for commercial use. Only five percent of the hardwood species are 11.0 inches or more in diameter and only seven percent of the softwoods are over seven inches in diameter. Most of the forest land is in private ownership, in small, scattered tracts. Public ownership accounts for only 16,000 acres.

Forest lands are divided into five ecosystems: coniferous, oak-hickory, elm-ash-cottonwood, maple-beech-birch, and aspen-birch. The coniferous ecosystem consists primarily of white, red, and jack pines; hemlock; tamarack; and northern white cedar. The oak-hickory ecosystem consists mostly of white oak, red oak, hickory, yellow poplar, black walnut and black cherry. The elm-ash-cottonwood ecosystem consists predominately of elm, ash and cottonwood species. The maple-beech-birch ecosystem is comprised of yellow birch, maples, beech, and basswood. The aspen-birch ecosystems consists basically of balsam poplar, aspens, and paper birch.

The oak-hickory and elm-ash-cottonwood ecosystems comprise over half the forest land. The maple-beech-birch ecosystem makes up another 18 percent, and the remaining acreage is split between the coniferous and aspen-birch ecosystems.

The forests are managed according to four general strategies. These four "management strategies" are called current management, multiple use, environmental emphasis, and maximum fiber.

Presently, the majority of forest land, 82 percent or 331,500 acres, falls into the "current management" category. The name itself is really a misnomer, because most of these lands are unmanaged woodlots. Many are the forgotten back woods on an agricultural enterprise. Trees are occasionally harvested when they reach a salable size. Usually only the more desirable trees are removed, leaving the poorly formed, decayed, and undesirable species. This is known as high-grading, a poor management practice. Many times erosion control is not practiced and disturbed areas caused by the logging leave lasting scars producing silt for Basin streams. Areas in this category very seldom receive attention in the form of cultural stand improvements to improve growth, form, and vigor. Often, grazing is permitted in these stands causing soil compaction and disturbance. Insect and disease control is not practiced either. This, too, reduces chances for a healthy and well formed stand of trees.

Ten percent or 41,900 acres of the forested lands are managed for "multiple use." This category is characterized by the development of a management plan to produce several products, such as wildlife and timber, or recreational use and aesthetics. Whatever the combination, a course of action has been planned to produce those outputs while maintaining the quality and productive capabilities of the land. Timber may be removed periodically, but is done in a way not to damage the land and to perpetuate the remaining stand's quality. Cultural improvements are installed to insure continued stand health, growth, and vigor.

Six percent of the forested lands are maintained in their natural state and have been placed into the "environmental emphasis" category. Wildlife sanctuaries, nature study areas, and the increasing number of privately owned forests being held as natural areas are within this classification. Most areas in this classification have little or no man-caused disturbances and produce a limited set of outputs. Health, vigor, and growth in these stands ranges anywhere between good and extremely poor.

The "maximum fiber" management strategy is applied to only two percent of the 9,600 acres of Basin forests. Areas which are in this classification are managed primarily for timber production. Professionally developed management plans are followed to provide optimum growth, vigor, and tree health. Cultural treatments provide young and developing trees the opportunity to excel. Trees are harvested periodically depending on the individual area's needs and capabilities. Disturbances of forest soils from logging roads and trails are kept to a minimum and treated upon completion of the operation to assure quick recovery. Livestock grazing is not permitted. Insect, disease, and fire protection and control efforts are intensive. Forest stands in this category display a very high level of forest growth, health, and vigor.

WATER USE

There are 537 farms which irrigate 16,819 acres. These farms use an average of 7.6 inches of water per year. Surface water supplies are used in about 50 percent of the systems including some use of Lake Michigan. Ground water is a source for the remaining systems. Water for livestock and insect/weed control may be drawn from either surface waters or ground waters.

Present rural water use is estimated to be 9,730 million gallons per year with domestic uses accounting for 5,555 million gallons. Ground water is the primary source of water supply uses.

CHAPTER VI

Future Conditions Without This Plan and Effects of Existing Programs

CHAPTER VI

FUTURE CONDITIONS WITHOUT THIS PLAN AND EFFECTS OF EXISTING PROGRAMS

An essential part of the planning process is the projection of changes that are expected to occur in the future without implementing this plan. Estimates are made of conditions that will occur by 1990 and 2020, if present trends in the use of the agricultural resources continue, and if existing governmental programs are utilized as they have been in the past. These future conditions without a plan will be compared with the desired conditions (Chapter IV) in Chapter VII to determine the Basin's specific resource needs.

FUTURE USE OF THE AGRICULTURAL RESOURCE

Food requirements are expected to rise over the next 50 years due to higher population and changing eating habits. Of the crops identified in Table 6-1, only wheat and oats requirements are expected to decline by 2020. Livestock products are not shown but are the basis for hay and silage projections. Only lamb and mutton, chickens and eggs, and milk requirements should fall. Beef and veal, pork and turkeys are expected to rise.

Given the effects of existing programs and anticipated improvements in crop yields, the Basin's resource base is expected to be able to meet its future food requirements as derived from the national OBERS projections without implementation of this plan. Table 6-1 shows that in 1990 and 2020, as well as currently, there will be a significant amount of idle cropland available if needed for greater production. In addition, "other open" cropland--acres that have been out of production considerably longer than "idle" cropland--should be available if necessary. At the same time, it is pointed out that over the 50-year period, the total amount of such available cropland declines some 15 percent.

TABLE 6-1--COMPARISON OF RESOURCE CONDITIONS
WITHOUT THIS PLAN

	Units (1,000's)	Current Situation	Without Plan 1990	Without Plan 2020
Cropland/pasture in production	acres	819	764	795
Idle cropland	acres	79	86	67
Other open cropland	acres	196	212	166
TOTAL	acres	1,094	1,062	1,028
Production				
Corn, grain	bushels	15,280	23,540	31,960
Corn, silage	tons	370	570	780
Soybeans	bushels	460	1,050	1,480
Wheat, oats	bushels	2,410	2,230	1,730
Hay	tons	630	600	650
Fruits 1/	tons	200	190	210
Vegetables	cwt	730	880	913
Cost 2/	$	30,093	33,145	39,170
Erosion Level	tons	2,315	1,885	1,956
Conventional tillage	acres	345	279	254
Minimum tillage	acres	116	104	135
No tillage	acres	4	43	75
Fertilizer Application	tons	58	63	82
Forest Land				
Area Managed	%	18	36	53
Area Managed	acres	73	148	223
Annual Hardwood Growth 3/				
Poletimber	cunit	38	81	58
Sawtimber	cunit	30	21	25
Production cost	index	100	149	127

1/ Apples, cherries, grapes, peaches, pears, plums, prunes.
2/ Corn, soybeans, wheat, oats, hay.
3/ Cunits = 100 cubic feet.

A substantial expansion in minimum and "no" tillage practices (from 120,000 acres currently, to 147,000 acres in 1990, and 210,000 acres in 2020) and a contraction in conventional tillage will mean lower erosion.

rates for the Basin as a whole (Figure 6-1). Gross erosion from cropland and pasture is expected to fall nearly one-fifth by 1990 and to rise less than five percent between 1990 and 2020. Fertilizer applications will rise, but reduced soil loss should mean less water pollution from both soil and fertilizer as well as from pesticides used for insect, weed, and disease control.

FIGURE 6-1 CORN SEVEN WEEKS OLD PLANTED ON SUDAN RESIDUE USING THE NO-TILL METHOD

On forest land, modest managerial changes that will enhance the forest environment, increase poletimber growth over current levels, and reduce the decline in hardwood sawtimber growth are expected to occur. Specifically, poletimber growth will increase from 38,000 cunits (3.8 million cubic feet) currently to 81,000 cunits in 1990 and to 58,000 cunits in 2020. Sawtimber growth is expected to fall from 30,000 cunits currently to 21,000 cunits in 1990 and 25,000 cunits in 2020.

Over one-third of the forest land is expected to be managed by 1990 and one-half by 2020 compared to less than one-fifth today. Timber stand improvement measures are expected to be applied on 28,800 acres

by 1990 and on 61,900 acres by 2020. Erosion on forest land, although minor compared to that on cropland, is expected to decline about one-fourth to 115,000 tons per year.

Basin food and fiber requirements are derived from a national set of projections, the OBERS Series E'. It is important to be aware of the assumptions that underlie any projections of future conditions, since they are critical to the conclusions reached. Thus, the major assumptions are briefly stated.

1. OBERS population projections assume that births and deaths will approach equality by 2020 and fertility will be close to the "replacement level." Basin population will thus rise to 665,000 persons in 1990 and to 780,000 in 2020.

2. The national economy will have reasonably full employment, represented by a four percent unemployment rate. Productivity will rise at a three percent annual rate. Economic growth will be accompanied by pollution controls in order to avoid serious deterioration of the environment.

3. OBERS agricultural projections are based on domestic demand and supply and on foreign exports. Domestic demand projections assume that real personal disposable incomes will rise four percent annually. Export projections assume a fall from the currently high levels, an immediate rebuilding of food stocks, and a major role for the U.S. as a supplier of coarse grains and wheat.

4. Michigan's share of national agricultural requirements are based on trends between 1947 and 1970. The Basin's share of the state will remain at the level of the early 1970's.

5. Yields for corn, oats, and soybeans are expected to increase 20 percent by 1990 and 40 percent by 2020; yields for wheat are expected to increase 30 percent and 50 percent respectively. The yield increase for the Basin is conservative relative to projections used by OBERS for Michigan (Table 6-2). This stems from yield relationships existing between Michigan and its southwestern counties during the early 1970's and the potential estimated by the USDA study team for the Basin.

6. Minimum and "no" tillage methods will be increasingly used in the Basin to reduce soil loss, pollution of adjacent waterways, and labor costs. Use of these methods will expand from 25 percent of cultivated cropland acres currently, to 34 percent in 1990, and to 50 percent in 2020.

TABLE 6-2--PERCENT CHANGE IN CROP YIELDS

Crop	1973-1990		1973-2020	
	OBERS	Basin	OBERS	Basin
	Percent Change			
Wheat	31	30	56	50
Corn	42	20	75	40
Oats	36	20	65	40
Soybeans	16	20	29	40

7. Modest efforts will be made to raise average annual growth of the forest resource by bringing an increasing number of acres under management. General management strategies labelled environmental emphasis, maximum fiber, and multiple use will be practiced on 36 percent of the resource by 1990 and 53 percent by 2020 compared to 18 percent currently. Application of timber stand improvement measures will reduce the number of acres needing treatment by nearly one-fifth by 1990 and by an additional one-fourth by 2020.

Appendix B discusses in more detail the linear program projections of future agricultural and forestry condition.

FUTURE CONDITIONS WITHOUT THIS PLAN

There are numerous governmental programs which are now being utilized to remedy some of the problems which exist in the Basin. Some programs are not extensively used because of a lack of matching funds. Overall, however, some things are being accomplished. Future conditions related to each study objective were projected based on past accomplishments of existing programs. If program accomplishments required large group or project type action, accomplishments were not projected. Therefore, more will probably be accomplished than is projected.

REDUCE EROSION ON CROPLAND TO AN ACCEPTABLE LEVEL

Technical assistance and/or financial assistance for the installation of soil erosion control measures is available through several USDA programs. These on-going programs will provide adequate treatment to nearly 50,000 acres of cropland with a critical erosion problem by the year 1990, and an additional 51,000 acres by 2020, based on current

trends of installation. Acreage under "minimum" and "no" tillage is expected to increase 27,000 acres by 1990 and 90,000 acres by 2020. A breakdown of future contributions by county is found in Table 6-5 and 6-6 at the end of this chapter. Land use changes, such as cropland being converted to urban development or forest land, are not expected to significantly reduce the problem since active cropland average is expected to remain relatively unchanged, while open or idle cropland will decline (Table 6-1).

The Soil Conservation Service provides technical assistance under authority given by the Soil Conservation Act (Public Law 46, 74th Congress, 1935). This assistance is given to landowners and operators through requests to local soil and water conservation districts. A soil conservation district is a legal subdivision of State government responsible for the conservation and development of soil and water resources within its boundaries. Landowners, as cooperators with a soil conservation district, receive assistance from the district according to policy established by the District Board of Directors.

Financial assistance is available through Agricultural Conservation Program (ACP) to accomplish erosion control measures as well as other conservation and pollution control measures. The program is administered by the Agricultural Stabilization and Conservation Service.

Technical and financial assistance is also available for the control of critically eroding areas in Van Buren and Berrien Counties through the Resource Conservation and Development Projects (RC&D), authorized by the Food and Agriculture Act of 1962 (Public Law 87-703). Both counties lie within the Sauk Trails Resource Conservation and Development Project which is run by the RC&D Council, made up of representatives of the Soil Conservation Districts and County Boards of Commissioners who are Project Sponsors. This Council is responsible for all aspects of the RC&D program.

REDUCE AGRICULTURAL FLOOD DAMAGE AND IMPROVE CROPLAND DRAINAGE ON EXISTING CROPLAND

This study objective applied to the four areas with extensive amounts of cropland with flooding and drainage problems described in Chapter III. Average annual damages due to this problem are expected to continue, since agricultural activities will remain at about the present level and project action to correct the problem is not anticipated through existing local, State or Federal programs. Outside of these four areas, less than four percent of the active cropland has a flooding and drainage problem.

PROVIDE ADDITIONAL PUBLIC ACCESS TO STREAMS

There are five public access sites to streams in Allegan County and one site in Van Buren County. No additional sites are presently planned.

PROVIDE ADDITIONAL LAND FOR HUNTING

There is an estimated 400,000 acres of public and private land available for hunting. By 1990, this is expected to decline to 292,000 acres and by 2020, to 184,000 acres, based on information from the *1974 Michigan Recreation Plan*. There are no programs available to offset this loss of land.

PROVIDE MANAGED RECREATION TRAILS

There are 30 miles of trails for nonmotorized recreational use in the Basin. The development of two planned trails would increase this to 138 miles. These include the Kal-Haven Trail (Kalamazoo and Van Buren Counties) and the North Country Trail (Hillsdale, Calhoun and Barry Counties). Presently there are no plans for additional trails.

REDUCE URBAN FLOOD DAMAGE

Plans are being considered to reduce flood damages at Lakewood on Davis Creek under the Michigan Drain Code. The installation of flood control measures will reduce damages to existing properties $16,700 by 1990 and $28,000 by 2020..

PROVIDE TREATMENT OF LIVESTOCK WASTES

Assistance for the installation of livestock waste treatment facilities is available from the Soil Conservation Service under the Soil Conservation Act and from the Agricultural Stabilization and Conservation Service through the Agricultural Conservation Program. (See page 6-6.) It is estimated that these programs will assist in the establishment of 94 animal waste treatment systems by the year 1990 and 232 by 2020.

PROTECT AND ENHANCE WETLAND WILDLIFE HABITAT

Wetland wildlife habitat can be enhanced through several existing USDA programs. Technical assistance is available through the Soil Conservation Districts. In Berrien and Van Buren Counties, the Resource Conservation and Development Sauk Trails Project may provide assistance to acquire land and develop sites for public water-based recreation and fish and wildlife purposes. The Water Bank Program is available in Jackson, Hillsdale and Van Buren Counties to preserve, restore and improve wetlands. In addition, the Wildlife Division of the Michigan Department of Natural Resources may provide technical assistance to landowners for specific wetland wildlife habitat problems.

To date, approximately 9,400 acres have been enhanced. It is estimated that 9,400 acres will be enhanced through existing programs by 1990, and a total of 37,600 by 2020. Approximately 20,200 acres of wetland are considered protected by virtue of being owned by the State, Counties or private conservation organizations.

IMPROVE UPLAND WILDLIFE HABITAT

Upland wildlife habitat improvement assistance to individual landowners is available from the Soil Conservation Service working through local Soil Conservation Districts. Practices such as field borders, hedgerows, ponds, and upland habitat management can be established.

Through the Agricultural Stabilization and Conservation Service, cost-sharing is available to qualified landowners for practices of value to wildlife which include water impoundment reservoirs, permanent wildlife habitat, tree planting, and streambank stabilization.

It is projected that 67,000 acres of private lands within the basin will be enhanced by existing Federal programs by 1990 and 194,000 acres by the year 2020.

PROTECT PRIME AGRICULTURAL LAND

Michigan's Farmland and Open Space Preservation Act of 1974 (Act 116) will help satisfy this study objective. Although the program is new it appears that more and more people are taking advantage of it. Through this program approximately 17,700 acres or about 10 percent of the prime cropland will be protected by 1990, and 60,000 acres or 35 percent by 2020. Presently, about 1,200 acres are being lost each year to urban related uses. If this continues, by 1990 there will be about 155,000 acres remaining and by 2020, 124,000 acres.

This Act enables a landowner to enter into a development rights agreement (for farmland) or a development rights easement (for open space) with the State. These agreements or easements are designed to ensure that the land remains in a particular use or uses for an agreed upon period, usually 10 years. In return for maintaining the land in a particular use, the landowner is entitled to certain income or property tax benefits. Thus, the land is assessed at its value for its present use rather than its value for residential or industrial use.

MANAGE AND ENHANCE ADDITIONAL FOREST LAND

Increased growth and yields of hardwood sawtimber, and increased management to improve forest health, vigor, and utilization will be accomplished in part by several State and State-Federal cooperative programs. There are two Michigan State forest tax acts which are designed to benefit forest landowners who are interested in growing commercial timber crops.

The Commercial Forest Act of 1925 applies to forest tracts of 40 acres or larger. The program provides tax relief to the landowner if the land is, 1) managed for timber production, 2) open to public hunting and fishing, and 3) not used for other commercial purposes. There are other conditions which must be met. Applications and administration are handled by the Michigan Department of Natural Resources.

The other State forest tax act is known as the Private Forest Reserve Act of 1917. This applies to smaller tracts, primarily farm woodlots of not greater than 40 acres. The main conditions for participation in the program and the associated tax relief are, 1) that the woodlot be used exclusively for timber crops, 2) that the tract be fully stocked with commercial tree species, and 3) that pasturing by domestic animals be prohibited.

Each of the programs encourages improvement of forest growth, health, and vigor by providing landowners with tax relief incentives. When administered and implemented properly, forest management and timber production all may improve significantly.

The Michigan Department of Natural Resources also provides assistance to landowners under a variety of cooperative U.S. Forest Service--State programs. Among these are the production and distribution of tree seedlings, technical assistance for woodlot management, technical assistance to improve production and utilization (to local forest product industries), and for a variety of cultural treatments to improve tree growth. Additional services are available from the Soil Conservation Service, Extension Service, and private industry.

Cost share dollars are available to landowners through the Agricultural Conservation Program and the Forestry Incentives Program (FIP); both administered by the Agricultural Stabilization and Conservation Service (ASCS) for the installation of land treatment measures.

Through these programs and the initiative of individual landowners, managed forest area is expected to rise from 73,400 acres currently to 148,400 acres in 1990 and 223,100 acres in 2020. Timber stand improvement measures will be applied on 28,800 acres of this land by 1990 and on 61,900 acres by 2020.

OTHER OBJECTIVES

The future condition of the remaining two study objectives is expected to be about the same as the present condition. Even though some assistance is available through existing State and Federal programs, accomplishments are unlikely. The main reason for this is the lack of organized local support.

Study objectives in this group are:

1. Reduce streambank erosion
2. Protect and manage stream corridors

TABLE 6-3--FUTURE WITHOUT CONDITION--1990

Study Objectives	Unit	County										
		Allegan	Barry	Berrien	Calhoun	Eaton	Hillsdale	Jackson	Kalamazoo	Ottawa	Van Buren	Basin
1. Reduce Cropland Erosion	Acres	6,400	3,000	2,000	21,300	1,500	450	1,650	7,600	5,100	1,000	50,000
2. Reduce Agri. Flooding & Drainage Damage	Dollars	-	-	-	-	-	-	-	-	-	-	-
3. Provide Additional Public Access	Sites	5	-	-	-	-	-	-	-	-	1	6
4. Provide Additional Hunting Land	Acres	110,800	20,400	9,600	38,300	9,600	4,800	12,000	28,200	12,000	46,300	292,000
5. Provide Managed Recrea. Trails	Miles	17	43	0	35	0	5	0	14	0	24	138
6. Reduce Urban Flooding Damage	Dollars	-	-	-	-	-	-	-	-	16,700	-	16,700
7. Treat Livestock Waste	Farms	10	8	4	15	15	12	10	5	10	5	94
8. Reduce Streambank Erosion	Miles	-	-	-	-	-	-	-	-	-	-	-
9. Protect Wetland Wildlife Habitat	Acres	7,200	1,900	1,000	3,100	700	600	1,600	2,200	300	1,600	20,200
10. Enhance Wetland Wildlife Habitat	Acres	3,200	1,800	1,000	3,400	200	200	200	7,000	200	1,600	18,800
11. Improve Upland Wildlife Habitat	Acres	18,700	4,000	2,700	10,700	2,700	1,300	3,400	7,400	3,400	12,700	67,000
12. Protect Stream Corridors	Miles	-	-	-	-	-	-	-	-	-	-	-
13. Protect Prime Agricultural Land	Acres	2,400	-	2,400	2,700	2,700	2,700	-	-	2,400	2,400	17,700
14. Manage and Enhance Additional Forest Land	Acres	-	-	-	-	-	-	-	-	-	-	148,400 1/

1/ Developed for Basin only.

TABLE 6-4--FUTURE WITHOUT CONDITION--2020

Study Objectives	Unit	County										
		Allegan	Barry	Berrien	Calhoun	Eaton	Hillsdale	Jackson	Kalamazoo	Ottawa	Van Buren	Basin
1. Reduce Cropland Erosion	Acres	19,000	3,000	2,000	33,000	5,000	1,000	5,000	15,000	15,000	3,000	101,000
2. Reduce Agri. Flooding & Drainage Damage	Dollars	-	-	-	-	-	-	-	-	-	-	-
3. Provide Additional Public Access	Sites	5	-	-	-	-	-	-	-	-	1	6
4. Provide Additional Hunting Land	Acres	80,600	13,900	5,200	21,100	5,200	2,600	6,600	16,300	6,600	25,900	184,000
5. Provide Managed Recrea. Trails	Miles	17	43	0	35	0	5	0	14	0	24	138
6. Reduce Urban Flooding Damage	Dollars	-	-	-	-	-	-	-	28,000	-	-	28,000
7. Treat Livestock Waste	Farms	25	30	4	45	45	23	15	10	20	15	232
8. Reduce Streambank Erosion	Miles	-	-	-	-	-	-	-	-	-	-	-
9. Protect Wetland Wildlife Habitat	Acres	7,200	1,900	1,000	3,100	700	600	1,600	2,200	300	1,600	20,200
10. Enhance Wetland Wildlife Habitat	Acres	6,400	3,600	2,000	6,800	400	400	400	14,000	400	3,200	37,600
11. Improve Upland Wildlife Habitat	Acres	54,300	11,600	7,800	31,000	7,800	3,900	9,700	21,300	9,700	36,900	194,000
12. Protect Stream Corridors	Miles	-	-	-	-	-	-	-	-	-	-	-
13. Protect Prime Agricultural Land	Acres	15,000	1,000	8,000	5,000	4,000	4,000	-	-	8,000	15,000	60,000
14. Manage and Enhance Additional Forest Land	Acres	-	-	-	-	-	-	-	-	-	-	223,100 1/

1/ Developed for Basin only.

CHAPTER VII

Needs

CHAPTER VII

NEEDS

To satisfy the "desired future" conditions for the years 1990 and 2020 (described in Chapter IV) certain improvements must occur. Some improvements (described in Chapter VI) would take place without a Basin plan and the implementation efforts of the Citizens Advisory Council and the County Task Forces. The additional improvements required to reach the "desired future" conditions are called "needs".

To facilitate meeting the two national objectives specified by *Principles and Standards for Water and Related Land Resource Planning* (Chapter III) the needs are categorized under National Economic Development (NED) Objective or Environmental Quality (EQ) Objective.

Needs considered in the National Economic Development Objective category include reducing erosion on cropland; reducing flood damage; providing public access to streams, recreational trails, and additional hunting lands; and managing and enhancing additional forest land (Table 7-1). Environmental Quality Objective Needs identified are reducing erosion on cropland, treating livestock waste; protecting wetlands, natural and scenic streams, and prime agricultural land; improving fish and wildlife habitat; and managing and enhancing additional forest land (Table 7-2). Needs are summarized by county in Table 7-3 and 7-4.

TABLE 7-1--NATIONAL ECONOMIC DEVELOPMENT OBJECTIVE NEEDS 1/

Study Objectives	Unit	1990 Desired 2/ Future Condition	1990 Future 3/ Without Condition	1990 Needs	2020 Desired 4/ Future Condition	2020 Future 5/ Without Condition	2020 Needs
Reduce erosion on cropland	Acres	166,000	50,000	116,000	166,000	101,000	65,000
Reduce agricultural flood damage and improve drainage	Acres Dollars (annual)	3,320 107,300	0 0	3,320 107,300	3,320 107,300	0 0	3,320 107,300
Provide additional public access to streams	Number of Sites	202	6	196	221	6	215
Provide hunting land	Acres	546,000	292,000	254,000	595,000	184,000	411,000
Provide recreational trails	Miles	250	138	140 6/	275	138	164 6/
Reduce urban flood damage	Dollars (annual)	61,300	16,700	44,600	102,600	28,000	74,600
Manage and enhance additional forest land	Acres	214,500	148,400	66,100	284,200	223,100	61,100

1/ All figures are cumulative.
2/ From Table 4-3
3/ From Table 6-3
4/ From Table 4-4
5/ From Table 6-4
6/ Needs determined for individual counties (Table 7-3 and 7-4).

TABLE 7-2--ENVIRONMENTAL QUALITY OBJECTIVE NEEDS 1/

Study Objective	Unit	1990 Desired 2/ Future Condition	1990 Future 3/ Without Condition	1990 Needs	2020 Desired 4/ Future Condition	2020 Future 5/ Without Condition	2020 Needs
Reduce erosion on cropland	Acres	166,000	50,000	116,000	166,000	101,000	65,000
Accelerate treatment of livestock waste	Farms	329	94	235	329	232	97
Reduce streambank erosion	Miles	430	0	430	430	0	430
Protect wetlands	Acres	121,800	20,200	101,600	121,800	20,200	101,600
Enhance wetlands	Acres	121,800	18,800	103,000	121,800	37,600	84,200
Improve upland wildlife habitat	Acres	367,900	67,000	300,900	367,900	194,000	173,900
Protect stream corridors	Miles	374	0	374	374	0	374
Protect prime agricultural land	Acres	175,100	17,700	157,400	175,100	60,000	115,100
Manage and enhance additional forest land	Acres	214,500	148,400	66,100	284,200	223,100	61,100

1/ All figures are cumulative.
2/ From Table 4-3
3/ From Table 6-3
4/ From Table 4-4
5/ From Table 6-4

TABLE 7-3--NEEDS--1990

Study Objectives	Unit	County										
		Allegan	Barry	Berrien	Calhoun	Eaton	Hillsdale	Jackson	Kalamazoo	Ottawa	Van Buren	Basin
1. Reduce Cropland Erosion	Acres	28,600	0	0	11,700	14,500	2,550	9,350	7,400	19,900	22,000	116,000
2. Reduce Agr. Flooding & Drainage Damage	Dollars	33,600	0	0	0	20,800	0	0	0	52,900	0	107,200
3. Provide Additional Public Access	Sites	51	7	11	61	7	5	8	14	4	28	196
4. Provide Additional Hunting Land	Acres	42,200	12,600	12,400	48,700	12,400	6,200	15,000	31,800	15,000	57,700	254,000
5. Provide Managed Recrea. Trails	Miles	53	0	10	5	10	0	15	11	15	21	140
6. Reduce Urban Flooding Damage	Dollars			44,600								44,600
7. Treat Livestock Waste	Farms	20	49	0	62	38	11	6	12	21	16	235
8. Reduce Streambank Erosion	Miles	104	0	9	100	49	4	21	5	66	72	430
9. Protect Wetland Wildlife Habitat	Acres	10,000	8,000	7,100	18,700	4,200	4,500	11,200	12,000	200	25,700	101,600
10. Enhance Wetland Wildlife Habitat	Acres	14,000	8,100	7,100	18,400	4,700	4,900	12,600	7,200	300	25,700	103,000
11. Improve Upland Wildlife Habitat	Acres	113,800	15,200	7,300	50,100	10,500	6,900	12,200	35,300	9,300	40,300	300,900
12. Protect Stream Corridors	Miles	69	19	36	79	18	9	32	30	9	73	374
13. Protect Prime Agricultural Land	Acres	50,700	5,000	10,800	4,200	3,600	5,100	3,000	900	21,100	53,000	157,400
14. Manage and Enhance Additional Forest Land	Acres	-	-	-	-	-	-	-	-	-	-	66,100 1/

1/ Developed for Basin only.

TABLE 7-4--NEEDS--2020

Study Objectives	Unit	County										
		Allegan	Barry	Berrien	Calhoun	Eaton	Hillsdale	Jackson	Kalamazoo	Ottawa	Van Buren	Basin
1. Reduce Cropland Erosion	Acres	16,000	0	0	0	11,000	2,000	6,000	0	10,000	20,000	65,000
2. Reduce Agr. Flooding & Drainage Damage	Dollars	33,600	-	-	-	20,800	-	-	-	52,900	-	107,300
3. Provide Additional Public Access	Sites	52	9	13	63	9	7	10	16	6	30	215
4. Provide Additional Hunting Land	Acres	85,400	22,100	18,800	73,900	18,800	9,400	23,400	48,700	23,400	87,100	411,000
5. Provide Managed Recreat. Trails	Miles	59	0	11	9	11	0	15	16	15	28	164
6. Reduce Urban Flooding Damage	Dollars			74,600								74,600
7. Treat Livestock Waste	Farms	5	27	0	32	8	0	1	7	11	6	97
8. Reduce Streambank Erosion	Miles	104	0	9	100	49	4	21	5	66	72	430
9. Protect Wetland Wildlife Habitat	Acres	10,000	8,000	7,100	18,700	4,200	4,500	11,200	12,000	200	25,700	101,600
10. Enhance Wetland Wildlife Habitat	Acres	10,800	6,300	6,100	15,000	4,500	4,700	12,400	200	100	24,100	84,200
11. Improve Upland Wildlife Habitat	Acres	78,200	7,600	2,200	29,800	5,400	4,300	5,000	21,400	3,000	16,100	173,900
12. Protect Stream Corridors	Miles	69	19	36	79	18	9	32	30	9	73	374
13. Protect Prime Agricultural Land	Acres	38,100	4,000	5,200	1,900	2,300	3,800	3,000	900	15,500	40,400	115,100
14. Manage and Enhance Additional Forest Land	Acres	-	-	-	-	-	-	-	-	-	-	61,100 1/

1/ Developed for Basin only.

CHAPTER VIII

Alternative Plans

CHAPTER VIII

ALTERNATIVE PLANS

Two alternative plans were developed for each county to help the County Task Forces develop their own plans. These plans were designed to satisfy the 1990 needs of each county. The alternative plans provided a range of resource management measures, since one plan emphasized economic development while the other emphasized environmental enhancement and protection.

The elements of the alternative county plans were combined into two alternative Basin plans--the National Economic Development Plan and the Environmental Quality Plan. Since the basic planning took place within each county, it was not possible to balance the deficiencies of one county with the unused resource opportunities in another county.

The forest land element of the plans was developed from Basin-wide data. Elements were not prepared for each county. Both alternative Basin plans contain the forest land element since it satisfies both national objectives without creating a conflict.

The beneficial and adverse effects of each element are estimated and displayed in the following tables. In order to describe expected impacts, the effects are evaluated from four viewpoints: 1) the national economy; 2) environmental quality; 3) the regional economy; and 4) social well-being.

Beneficial effects appearing in the national economic development (NED) account reflect increased production of goods and services and gains in production efficiency. They are presented on an average annual basis.

Adverse effects appearing in the NED account reflect the value of resources needed due to the plan element. The average annual costs in the accounts include, among other things, those for land acquisition, construction, maintenance, and administrative.

Beneficial effects appearing in the environmental quality (EQ) account reflect contributions resulting from the management, preservation, or restoration of the environmental characteristics of an area. Adverse effects reflect deteriorations in these characteristics. Since the nature of an effect--whether it is adverse or beneficial--is often a personal judgment, no distinction is made on the nature of an effect in the EQ account.

The procedures for measuring beneficial and adverse effects in the regional economic development (RD) account are generally the same as those for the NED account. Also included are the Federal and regional or local share of the costs.

Beneficial and adverse effects in the social well-being account reflect impacts of an element on the amount and distribution of real income, of health and safety, and on educational, cultural, and social opportunities.

NATIONAL ECONOMIC DEVELOPMENT PLAN

This plan was developed to enhance national economic development by increasing the value of the nation's output of goods and services and improve national economic efficiency. Fully implemented the plan would:

1. Reduce erosion on 116,000 acres of highly erodible cropland.

2. Reduce average annual crop damage by $107,300 due to flooding and inadequate drainage on 3,320 acres of cropland.

3. Provide 196 public access sites to 980 miles of stream for recreation.

4. Provide hunting opportunities on 254,000 acres of private land.

5. Provide 140 miles of non-motorized recreation trails.

6. Reduce average annual flood damage to property around Paw Paw Lake by $44,600.

7. Manage and enhance an additional 66,100 acres of forest land.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Reduce erosion on 116,000 acres of cropland to an acceptable level.

PLAN ELEMENT - Accelerate land treatment (70,000 acres of conservation cropping system, 64,000 acres of crop residue management, 88,000 acres of minimum tillage, 300 acres of grassed waterway, 200 grade stabilization structures, 4,000 feet windbreaks).

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Accelerated land treatment program not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation costs for land treatment	$586,500
2.	Technical assistance	110,000
	Total	$696,500

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion on 116,000 acres of cropland from an average of 7.0 tons/acre/year to 3.0 t/a/y.
2. Improve water quality in streams by reducing sediment concentrations.
3. Decrease agricultural nutrient contributions to streams.
4. Increase quality of terrestrial wildlife habitat on 116,000 acres.
5. Improve quality of aquatic ecosystems.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Accelerated land treatment program not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation costs for land treatment	$263,900	$322,600
2.	Technical assistance		110,000
	Total	$263,900	$432,600

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 27 jobs during the installation period.
2. Enhance visual quality of agricultural landscape on 116,000 acres.
3. Improve recreation activities in local areas, such as boating, swimming, and fishing.
4. Improve hunting on 116,000 acres.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Reduce flooding damages and poor drainage on 3,320 acres of cropland.

PLAN ELEMENT - Channel work on 24 miles of stream and three floodwater retarding structures.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	
Reduce annual flood damage and increase agricultural efficiency on 3,320 acres of cropland.	$107,200	1. Installation costs $625,000	$ 40,300
		2. Land rights $230,700	14,880
		3. O. M. & R.	12,300
		4. Administration $ 88,100	5,710
		Total	73,190

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Increase grassland wildlife habitat in channel area by 50 acres.
2. Decrease woody wildlife habitat in channel area by 48 acres.
3. Degrade aquatic ecosystem on 24 miles of stream.
4. Increase water temperatures on 24 miles of stream.
5. Increase sedimentation during construction.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	Region	Rest of Nation
Reduce annual flood damage and increase agricultural efficiency on 3,320 acres of cropland.	$107,200	1. Installation costs $625,000	$ 9,100	$ 31,200
		2. Land rights $230,700	14,880	
		3. O. M. & R.	12,300	
		4. Administration $ 88,100	1,900	3,810
		Total	$ 38,180	$ 35,010

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 30 jobs during the installation period.
2. Provide agricultural flood protection on 3,320 acres.
3. Change visual quality of the landscape along 24 stream miles.

1/ Average annual.

2/ Amortized 50-years @ 6 1/8 percent.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Provide public access to 980 miles of stream for recreation.

PLAN ELEMENT - Install 196 public access sites.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/		
Provide 328,300 recreation days @ .75/day.	$246,200	1. Installation costs	$1,654,200	$106,800
		2. Land rights	$ 39,200	2,500
		3. O. M. & R.		82,700
		Total		$192,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Increase in traffic, noise, litter, fishing, hunting, trapping will put stress on fish, wildlife and plant communities along 980 miles of stream.
2. Increase sedimentation in 980 miles of stream during construction.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/		Region	Rest of Nation
Provide 328,300 recreation days @ .75/day.	$246,200	1. Installation costs	$1,654,200	$106,800	-
		2. Land rights	$ 39,200	2,500	-
		3. O. M. & R.		82,700	-
		Total		$192,000	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce safety hazards of roadside parking and bridge fishing.
2. Provide local water based recreation on 980 miles of stream.
3. Create 76 jobs during the installation period.

1/ Average annual.

2/ Amortized 50 years @ 6 1/8 percent.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Provide hunting opportunities on private land.

PLAN ELEMENT - Lease 254,000 acres hunting lands at county level by sale of permits to hunters.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/	
Provide 337,820 hunter days at 2.25/day/year	$760,000	1. Lease costs	$381,000
		2. Administration	127,000
		Total	$508,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Increase in traffic, noise, litter, and hunting will put stress on wildlife and plant communities on 254,000 acres.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/		
			Region	Rest of Nation
Provide 337,820 hunter days at 2.25/day/year	$760,000	1. Lease costs	$381,000	-
		2. Administration	127,000	-
			$508,000	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Provide 337,820 hunter days/year.
2. Provide $381,000/year income to Basin landowners.
3. Increase safety hazard from increase in firearm use on 254,000 acres.
4. Create 27 jobs.

1/ Average annual.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Provide 140 single use miles of non-motorized recreation trail.

PLAN ELEMENT - Develop 70 miles of abandoned railroad rights-of-way.
Develop 70 miles of trail along rural roads, streams and on state-owned land.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	
Provide 210,000 recreation days/year @ 1.50/day.	$315,000	1. Installation costs $2,054,000	$132,600
		2. Land rights $ 945,000	61,000
		3. O. M. & R.	102,700
		Total	$296,300

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Increase in traffic, noise, litter and trail recreational activities will put stress on wildlife and plant communities along 140 miles (1,760 acres) of trails.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS		ADVERSE EFFECTS		
			Region	Rest of Nation
Provide 210,000 recreation days/year @ 1.50/day.	$315,000	1. Installation costs $2,054,000	$ 95,500	$37,100
		2. Land rights $ 945,000	43,900	17,100
		3. O. M. & R.	102,700	
		Total	242,100	54,200

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Provide 210,000 local recreation days/year for trail activities.
2. Increase traffic, noise, and litter in area.
3. Create 95 jobs during the installation period.

1/ Average annual.

2/ Amortized 50-years @ 6 1/8 percent.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Reduce urban flood damage on 172 acres.

PLAN ELEMENT - Provide structural flood protection measures for Paw Paw Lake

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	
Reduction of average annual flood damage to existing property.	$44,600	1. Structural costs $300,000	$18,400
		2. Project administration $ 25,000	1,500
		Total $325,000	$19,900

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/		
			Region	Rest of Nation
Reduction of average annual flood damage to existing property.	$44,600	1. Structural cost $300,000	$4,200	$14,200
		2. Project administration $ 25,000	500	1,000
		Total	$4,700	$15,200

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 14 jobs during the installation period.
2. Improve health and safety for flood plain users on 172 acres.

1/ Average annual.

2/ Amortized 100-years @ 6 1/8 percent.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Manage and enhance an additional 66,100 acres of forest land to increase fiber growth and yield and to improve enivronmental conditions.

PLAN ELEMENT - Increase forest land managed for "maximum fiber" from 18,800 acres to 30,300 acres; forest land managed for "multiple use" from 95,500 acres to 150,100 acres; and application of timber stand improvement measures from 28,800 acres to 59,800 acres.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Annual sawtimber growth increased approximately 18%. Not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation	$1,085,000
2.	Technical assistance	332,000
	Total	$1,417,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion rates, increase wildlife habitat values, improve growth, health and vigor of forest land.
2. Moderate short term disturbances while applying improvement measures.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Annual sawtimber growth increased approximately 18%. Not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation	$217,000	$868,000
2.	Technical assistance	232,000	100,000
	Total	$449,000	$968,000

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Small increase in hunter days.
2. Create 50 jobs during installation.
3. Increase regional awareness of importance of forested lands and their management.
4. Protect local forest industries from drastic raw material supply reductions.

SUMMARY NED PLAN
National Economic Development Account

Beneficial effects:	(Average Annual)
The value to users of increased outputs of goods and services.	
1. Flood prevention and drainage	
a. urban	$ 44,600
b. agricultural	107,200
Subtotal	$ 151,800
2. Recreation	
a. recreation trails	$ 315,000
b. hunting	760,000
c. access sites	246,200
Subtotal	$1,321,200
Total Beneficial Effects:	$1,473,000

Adverse effects: 1/	(Average Annual) 2/
The value of resources required for a plan.	
1. Channel work and floodwater retarding structures.	
a. Project installation	$ 58,700
b. O&M	12,300
c. Land rights	14,880
2. Recreational development	
a. Project installation	$ 620,400
b. OM&R	185,400
c. Land rights	63,500
3. Project administration	$ 134,210
Total Adverse Effects:	$1,089,390
Net Beneficial Effects:	$ 383,610

1/ Total cost of land treatment and forest land management $2,113,500. Benefits were not evaluated.
2/ Cost of recreational and agricultural flood prevention measures amortized 50-years @ 6 1/8 percent. Cost of urban flood prevention measures amortized 100-years @ 6 1/8 percent.

SUMMARY NED PLAN

Environmental Quality Account

Beneficial and adverse effects:

A. Quality consideration of water, land, and air resources.

1. Reduce erosion on 116,000 acres of cropland from an average of 7.0 tons/acre/year to 3.o t/a/y.
2. Improve water quality in streams by reducing sediment concentrations.
3. Decrease agricultural nutrients contribution to streams.
4. Increase water temperatures on 24 miles of stream..
5. Increase sedimentation during construction.
6. Reduce erosion rates, increase wildlife habitat values, improve growth, health and vigor of forest land.

B. Biological resources and selected ecosystems.

1. Increase quality of terrestrial wildlife habitat on 116,000 acres.
2. Improve quality of aquatic ecosystems.
3. Increase grassland wildlife habitat in channel area by 50 acres.
4. Decrease woody wildlife habitat in channel area by 48 acres.
5. Degrade aquatic ecosystem on 24 miles of stream.
6. Increase in traffic, noise, litter, fishing, hunting, trapping and recreation trails will put stress on fish, wildlife and plant communities along 980 miles of stream, 140 miles of trail and on 254,000 acres.

SUMMARY NED PLAN
Regional Development Account

Beneficial effects: (Average Annual)		Adverse effects: 1/	Region	Rest of Nation
			(Average Annual)	2/
The value of increased output of goods and services to users residing in the region.		The value of resources contributed to achieve the output.		
1. Flood prevention and drainage		1. Channel work and flood water retarding structures.		
a. urban	$ 44,600	a. project installation	$ 13,300	$ 45,400
b. agricultural	107,200	b. OM&R	12,300	-
		c. land rights	14,880	-
Subtotal	$ 151,800			
		2. Recreational development		
2. Recreation				
		a. project installation	$583,300	$ 37,100
a. recreation trails	$ 315,000	b. OM&R	185,400	-
b. hunting	760,000	c. land rights	46,400	17,100
c. access sites	246,200			
		3. Project administration	$129,400	$ 4,810
Subtotal	$1,321,200			
Total Beneficial Effects	$1,473,000	Total Adverse Effects:	$984,980	$ 104,410
		Net Beneficial Effects:	$488,020	$-104,410

1/ Total cost of land treatment, and forest land management $2,113,500. Benefits were not evaluated.
2/ Cost of recreational and agriculture flood prevention measures amortized 50-years @ 6 1/8 percent, cost of urban flood prevention measures amortized @ 100-years @ 6 1/8 percent.

SUMMARY NED PLAN

Social Well-Being Account

Beneficial and adverse effects:

A. Real income distribution.

1. Create 169 jobs during the installation period.
2. Provide $381,000/year income to Basin landowners.

B. Life, health and safety.

1. Enhance visual quality of agriculture landscape on 116,000 acres.
2. Improve health and safety for flood plain users on 172 acres.
3. Provide agricultural flood protection on 3,320 acres.
4. Change visual quality of the landscape along 24 stream miles.
5. Reduce safety hazards of roadside parking and bridge fishing.
6. Increase traffic, noise, and litter in area.
7. Increase safety hazard from increase in firearm use on 254,000 acres.
8. Increase regional awareness of importance of forested lands and their managements.
9. Protect local forest industries from drastic raw material supply reduction.

C. Recreational opportunities.

1. Improve recreation activities in local areas, such as boating, swimming and fishing.
2. Improve hunting on 116,000 acres.
3. Provide local water based recreation on 980 miles of stream.
4. Provide 210,000 local recreation days/year for trail activities.
5. Provide 337,820 hunter days/year.

ENVIRONMENTAL QUALITY PLAN

The Environmental Quality Plan outlines programs and developments that would provide for the preservation or enhancement of the environment. The beneficial and adverse effects of each element are described under the four accounts previously mentioned. Fully implemented, the plan would:

1. Reduce erosion on 166,000 acres of highly erodible cropland.

2. Accelerate the treatment of livestock wastes on 235 farms.

3. Reduce streambank erosion on 430 miles of stream.

4. Protect 101,600 acres of wetland habitat from expansion of cropland and urban areas.

5. Enhance 103,000 acres of wetland for waterfowl nesting.

6. Improve upland wildlife habitat on 300,900 acres.

7. Protect the natural and scenic values along 374 miles of stream corridors.

8. Protect 157,400 acres of prime agricultural land from other uses.

9. Manage and enhance an additional 66,100 acres of forest land.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Reduce erosion on 116,000 acres of cropland on the more erodible soils.

PLAN ELEMENT - Accelerated land treatment (70,300 acres of conservation cropping system, 64,300 acres of crop residue, 88,000 acres of minimum tillage, 332 acres of grassed waterway, 223 grade stabilization structures and 4,000 feet windbreaks).

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Accelerated land treatment program not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation costs for land treatment.	$586,500
2.	Technical assistance	110,000
	Total	$696,500

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion on 116,000 acres of cropland from an average of 7.0 tons/acre/year to 3.0 t/a/y.
2. Improve water quality in streams by reducing sediment concentrations.
3. Decrease agricultural nutrient contributions to streams.
4. Increase quality of terrestrial wildlife habitat on 116,000 acres.
5. Improve quality of aquatic

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Accelerated land treatment program not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation costs for land treatment.	$263,900	$322,600
2.	Technical assistance	-	110,000
	Total	$263,900	$432,600

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 27 jobs during the installation period.
2. Enhance visual quality of agricultural landscape on 116,000 acres.
3. Improve recreation activities in local such as boating, swimming and fishing.
4. Improve hunting on 116,000 acres.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Accelerate the treatment of livestock wastes on 235 farms.

PLAN ELEMENT - Install 85 holding tanks and 150 earth pits.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/ 2/		ADVERSE EFFECTS 2/ 3/	
Reduce annual loss of nutrients from farms.		1. Installation costs $2,812,900	$222,700
A. Nitrogen - 219,500 lbs.	$ 63,700	2. Technical assistance $281,300	22,300
B. Phosphorus - 21,800 lbs.	12,400	3. O. & M. costs	44,500
C. Potassium - 452,800 lbs.	45,300		
Total	$121,400	Total	$289,500

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality by reducing nutrient concentrations in streams and lakes.
2. Improve quality of aquatic ecosystem.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS		ADVERSE EFFECTS	Region	Rest of Nation
Reduce annual loss of nutrients from farms.		1. Installation costs $2,812,900	$ 55,700	$167,000
A. Nitrogen - 219,500 lbs.	$ 63,700	2. Technical assistance $281,300	-	22,300
B. Phosphorous - 21,800 lbs.	12,400	3. O. & M. costs	44,500	-
C. Potassium - 452,800 lbs.	45,300			
Total	$121,400	Total	$100,200	$189,300

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Create 94 jobs during the installation period.

1/ All benefits not evaluated.
2/ Average annual
3/ Amortized for 25-years @ 6 1/8 percent.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Reduce streambank erosion on 430 miles of stream.

PLAN ELEMENT - Erosion Control (Stabilize 205,400 feet of streambank. Install 15,840 feet of rock riprap. Install 193 acres of grassed waterway. Fence 258,720 feet of channel from livestock. Install 252 acres of buffer strips (20' wide). Install 33 drop inlet structures. Plant 153 acres of trees. Apply 95 acres of critical area treatment).

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation costs	$668,700
2.	Technical assistance	33,400
	Total	$702,100

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality for fish on 430 miles of stream by reducing sedimentation, nutrient runoff and water temperatures.
2. Improve wildlife habitat by planting permanent vegetation on 252 acres of channel bank.
3. Improve fish cover by increasing bank vegetation along 430 miles of stream.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation costs	$334,350	$334,350
2.	Technical assistance	16,700	16,700
	Total	$351,050	$351,050

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve fishery resource for recreation in watersheds that receive stream improvement.
2. Improve visual quality along 430 miles of stream.
3. Reduce maintenance for drainage on 430 miles of stream.
4. Create 31 jobs during the installation period.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Protect 101,600 acres of wetland from expansion of cropland and urban areas.

PLAN ELEMENT - Local wetland zoning.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS	
NOTE: Not evaluated in monetary terms.	Wetland inventory	$60,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Preserve 101,600 acres of wetlands for wildlife habitat, groundwater recharge, runoff nutrient utilization, floodwater storage.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS		
		Region	Rest of Nation
NOTE: Not evaluated in monetary terms.	Wetland inventory	$60,000	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Preserve visual quality of landscape on 101,600 acres.
2. Preserve 101,600 acres of wetlands for production of game and non-game wildlife species for recreation.
3. Continue production of insect pests from 101,600 acres of wetland.
4. Allow some wetlands to become safety hazards near urban developments.
5. Provide resource for development of outdoor classrooms.
6. Reduce landowners rights on 101,600 acres.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Enhance 103,000 acres of wetland for waterfowl nesting.

PLAN ELEMENT - Install waterfowl nesting platforms in 27,000 acres of marsh and open water wetlands at a rate of one/5 acres. Install waterfowl nesting boxes in 54,200 acres of wooded and 21,800 acres of shrub wetland at a rate of one/20 acres.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS	
NOTE: Not evaluated in monetary terms.	Installation costs	$131,900

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Increase waterfowl production on 103,000 acres of wetland.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS	Region	Rest of Nation
NOTE: Not evaluated in monetary terms.	Installation costs	$131,900	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Produce more waterfowl on 103,000 acres for recreation in region and rest of nation.
2. Create 6 jobs during the installation period.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Improve upland wildlife habitat on 300,900 acres.

PLAN ELEMENT - Make one acre openings at a rate of .5/section in each of approximately 550 sections that have more than 50 percent of their area in forest; underplant coniferous trees in 1,100 sections with more than 25 percent forest in forest land at a rate of 32-96 ac/section; plant conifer and/or shrub hedgerows in 410 sections with 50 percent or more of their area in cropland and less than five percent in wetlands; manage 65,600 acres of utility right-of-ways for wildlife habitat; use minimum or no tillage on 146,700 acres of corn land.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation costs	$1,853,400
2.	Technical assistance	92,700
	Total	$1,946,100

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Increase quantity and quality of wildlife habitat on 300,900 acres.
2. Reduce consumption of nonrenewable energy resources by reduced vegetative maintenance on 65,600 acres of right-of-way and 146,700 acres of cropland.
3. Increase availability of cropland food for wildlife on 146,700 acres.
4. Reduce soil erosion on 146,700 acres.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation costs	$1,390,100	$463,300
2.	Technical assistance	-	92,700
	Total	$1,390,100	$556,000

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve wildlife resources for recreation on 300,900 acres.
2. Enhance visual quality on 65,600 acres of right-of-way.
3. Increase frequency of wildlife on roads and railroads.
4. Increase fire and snow hazards in 12,200 acres of road rights-of-way.
5. Increase wildlife use on 146,700 acres of cropland.
6. Create 85 jobs during the installation period.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Protect 374 miles of stream corridors.

PLAN ELEMENT - Local greenbelt zoning.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS	
NOTE: Not evaluated in monetary terms.	Corridor delineation and protection	$112,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Preservation of 374 miles of stream corridor which include important habitats for fish, wildlife and plants.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS		
		Region	Rest of Nation
NOTE: Not evaluated in monetary terms.	Corridor delineation and protection	$112,000	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Restrict future development on 27,155 acres.
2. Reduce landowner rights on 27,155 acres.
3. Maintain visual quality of landscape on 27,155 acres.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Protect 157,400 acres of prime agricultural land from other uses.

PLAN ELEMENT - Implement Farmland and Open Space Preservation Act.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS **ADVERSE EFFECTS**

NOTE: Protection of prime cropland was not evaluated in monetary terms.

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Preserve 157,400 acres of agricultural wildlife habitat.
2. Prevent irreversible loss of 157,400 acres of prime cropland.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS **ADVERSE EFFECTS**

NOTE: Protection of prime cropland was not evaluated in monetary terms.

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Maintain existing visual quality of the agricultural landscape on 157,400 acres.
2. Stabilize agricultural industry and support services.
3. Insure production of agricultural wildlife for recreation on 157,400 acres of prime land.
4. Protect this valuable resource for future generations.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Manage and enhance an additional 66,100 acres of forest land to increase fiber growth and yield and to improve environmental conditions.

PLAN ELEMENT - Increase forest land managed for "maximum fiber" from 18,800 acres to 30,300 acres; forest land managed for "multiple use" from 95,500 acres to 150,100 acres; and application of timber stand improvement measures from 28,800 acres to 59,800 acres.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Annual sawtimber growth increased approximately 18 percent. Not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation	$1,085,000
2.	Technical assistance	332,000
	Total	$1,417,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion rates, increase wildlife habitat values, improve growth, health and vigor of forest land.
2. Moderate short term disturbances while applying improvement measures.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Annual sawtimber growth increased approximately 18 percent. Not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation	$ 217,000	$868.000
2.	Technical assistance	232,000	100,000
		$ 449,000	$968,000

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Small increase in hunter days.
2. Create 50 jobs during installation.
3. Increase regional awareness of importance of forested lands and their management.
4. Protect local forest industries from drastic raw material supply reductions.

SUMMARY EQ PLAN 1/
National Economic Development Account

Beneficial effects: 2/		Adverse effects 2/	
Benefits evaluated in monetary terms.		The value of required resources.	
Reduced annual loss of nutrients from farms.	$121,400	1. Installation	$ 222,700
		2. Technical assistance	22,300
		3. O & M Costs	44,500
Total Beneficial Effects Evaluated:	$121,400	Total Adverse Effect of Evaluated Plan Element	289,500
		Net Beneficial Effect	$-168,100

1/ The following study objectives were not evaluated in monetary terms, improve upland wildlife habitat, wetland enhancement for waterfowl nesting, reduce streambank erosion, reduce erosion on cropland, protect stream corridors, forest land management and protect wetland from expanding cropland and urban areas. Total cost of these objectives is $5,065,600.

2/ Average annual.

SUMMARY EQ PLAN
Environmental Quality Account

Beneficial and adverse effects:

A. Quality consideration of water, land, and air resources.

1. Preserve 157,400 acres of agricultural wildlife habitat.
2. Reduce erosion on 116,000 acres of cropland from an average of 7.0 tons/acre/year to 3.0 t/a/y.
3. Improve water quality in streams by reducing sediment concentrations.
4. Decrease agricultural nutrient contribution to streams.
5. Improve water quality by reducing nutrient concentration in streams and lakes.
6. Reduce consumption of nonrenewable energy resources by reduced vegetative maintenance on 65,600 acres of right-of-way and 146,700 acres of cropland.
7. Reduce soil erosion on 146,700 acres.

B. Biological resources and selected ecosystems.

1. Increase quality of terrestrial wildlife habitat on 116,000 acres.
2. Improve quality of aquatic ecosystems.
3. Preserve 101,600 acres of wetlands for wildlife habitat, groundwater recharge, runoff nutrient utilization, flood-water storage.
4. Increase waterfowl production on 103,000 acres of wetland.
5. Increase quantity and quality of wildlife habitat on 300,900 acres.
6. Increase availability of cropland food for wildlife on 146,700 acres.
7. Improve water quality for fish on 430 miles of stream by reducing sedimentation, nutrient runoff and water temperature.
8. Improve wildlife habitat by planting permanent vegetation on 252 acres of channel bank.
9. Improve fish cover by increasing bank vegetation along 430 miles of stream.
10. Preservation of 374 miles of stream corridor which include important habitats for fish, wildlife and plants.

C. Irreversible or irretrievable commitments.

Prevent irreversible loss of 157,400 acres of prime cropland.

SUMMARY EQ PLAN 1/
Regional Development Account

Beneficial effects: 2/		Adverse effects 2/	Region	Rest of Nation
Benefits evaluated in monetary terms.		The value of required resources.		
Reduced annual loss of nutrients from farms.	$121,400	1. Installation cost	$ 55,700	$167,000
		2. Technical assistance	-	22,300
		3. O & M Costs	44,500	-
Total Beneficial Effects Evaluated:	$121,400	Total Adverse Effects of Evaluated Plan Element	$100,200	$189,300
		Net Beneficial Effects:	$ 21,200	$-189,300

1/ The following study objectives were not evaluated in monetary terms, improve upland wildlife habitat, wetland enhancement for waterfowl nesting, reduce streambank erosion, reduce erosion on cropland, protect stream corridors, forest land management and protect wetland from expanding cropland and urban areas. Total cost of these objectives is $5,065,600.

2/ Average annual.

SUMMARY EQ PLAN
Social Well-Being Account

Beneficial and adverse effects:

A. Real income distribution.

Create 293 jobs during the installation period.

B. Life, health and safety.

1. Maintain existing visual quality of the agricultural landscape on 157,400 acres.
2. Stabilize agricultural industry and support services.
3. Protect valuable agricultural land for future generations.
4. Enhance visual quality of agricultural landscape on 116,000 acres.
5. Preserve visual quality of landscape on 101,600 acres.
6. Continue production of insect pests from 101,600 acres of wetlands.
7. Allow some wetlands to become safety hazards near urban development.
8. Provide resource for development of outdoor classrooms.
9. Reduce landowners rights on 101,600 acres.
10. Enhance visual quality on 65,600 acres of right-of-way.
11. Increase frequency of wildlife on raods and railroads.
12. Increase fire and snow hazards in 12,200 acres of road rights-of-way.
13. Increase wildlife use on 146,700 acres of cropland.
14. Improve visual quality along 430 miles of stream.
15. Reduce maintenance for drainage on 430 miles of stream.
16. Restrict future development on 27,155 acres.
17. Reduce landowners rights on 27,155 acres.
18. Maintain visual quality of landscape on 27,155 acres.

C. Recreational opportunities.

1. Insure production of agricultural wildlife for recreation on 157,400 acres of prime land.
2. Improve hunting on 116,000 acres.
3. Preserve 101,600 acres of wetlands for production of game and non-game wildlife species used for recreation.
4. Produce more waterfowl on 103,000 acres for recreation in region and rest of nation.
5. Improve wildlife resources for recreation on 300,900 acres.
6. Improve fishery resource for recreation in watersheds that receive stream improvement.

CHAPTER IX

Preferred Plan

CHAPTER IX

PREFERRED PLAN

Theoretically the ideal plan would satisfy all the needs, categorized under the study objectives (see Chapter VII), thus achieving the "desired future" conditions described in Chapter IV. However, this would not necessarily be the most practical or acceptable plan. In a practical sense, the ideal plan is one that will be implemented.

Each County Task Force attempted to assemble a plan that would be acceptable to the people in the county and that could be implemented by 1990. The plans reflect the people's concern for their environment. Most of the elements in each plan either protect or enhance the water and land resources--our environment.

The elements in the county plans were combined into the Basin Preferred Plan for this report (Table 9-1). The county plans are presented in separate county reports.

Some of the county plans contain elements that are not included in the Basin Preferred Plan. These elements were recommended by a County Task Force for a specific county.

Display tables show the effects of the Preferred Plan and a comparison of the plans.

Fully implemented, the Preferred Plan would:

1. Reduce erosion on 116,000 acres of cropland.

2. Reduce flooding damages and poor drainage on 2,750 acres of cropland (DenBleyker Drain, Allegan County; Battle Creek, Eaton County; and Macatawa River, Ottawa County).

3. Provide public access to 285 miles of stream by installing 57 public access sites.

4. Provide hunting opportunities on 122,000 acres of private land.

5. Provide 105 single-use miles of non-motorized recreational trails.

6. Protect 172 acres of property around Paw Paw Lake

7. Accelerate the treatment of livestock waste on 181 farms.

8. Reduce streambank erosion on 330 miles of stream.

9. Protect 65,200 acres of wetland.

10. Enhance 43,000 acres of wetland habitat for waterfowl nesting.

11. Improve upland wildlife habitat on 154,700 acres.

12. Protect the natural and scenic values along 291 miles of stream corridors.

13. Protect 157,400 acres of prime agricultural land.

14. Manage and enhance 66,100 additional acres of forest land.

TABLE 9-1--PREFERRED COUNTY PLANS - 1990

Study Objectives	Unit	County										
		Allegan	Barry	Berrien	Calhoun	Eaton	Hillsdale	Jackson	Kalamazoo	Ottawa	Van Buren	Basin
1. Reduce Cropland Erosion	Acres	28,600	-	-	11,700	14,500	2,600	9,300	7,400	19,900	22,000	116,000
2. Reduce Agri. Flooding and Drainage Damage	Dollars	13,600	-	-	-	20,800	-	-	-	52,800	-	87,200
3. Provide Additional Public Access	Sites	7	-	6	10	7	5	1	14	4	3	57
4. Provide Additional Hunting Land	Acres	42,200	9,400	-	-	9,300	-	3,800	31,800	11,200	14,300	122,000
5. Provide Managed Recreation Trails	Miles	20	-	3	31	8	3	-	20	15	5	105
6. Reduce Urban Flooding Damage	Dollars	-	-	74,600	-	-	-	-	-	-	-	74,600
7. Treat Livestock Waste	Farms	20	22	-	62	28	5	1	12	21	10	181
8. Reduce Streambank Erosion	Miles	104	1	9	33	49	4	21	5	32	72	330
9. Protect Wetland Wildlife Habitat	Acres	10,000	3,700	2,500	18,700	4,200	1,900	-	6,300	200	17,700	65,200
10. Enhance Wetland Wildlife Habitat	Acres	6,300	3,700	2,500	9,200	2,200	700	2,300	4,700	200	11,200	43,000
11. Improve Upland Wildlife Habitat	Acres	85,100	5,400	2,000	-	7,900	700	-	26,500	7,000	20,100	154,700
12. Protect Stream Corridors	Miles	53	-	36	79	15	9	32	4	9	54	291
13. Protect Prime Agricultural Land	Acres	50,700	5,000	10,800	4,200	3,600	5,100	3,000	900	21,100	53,000	157,400
14. Manage and Enhance Additional Forest Land	Acres	--- Not evaluated by counties ---										66,100

PREFERRED PLAN

STUDY OBJECTIVE - Reduce erosion on 116,000 acres of cropland on the more erodible soils.

PLAN ELEMENT - Accelerated land treatment (70,300 acres of conservation cropping system, 64,000 acres of crop residue, 88,000 acres of minimum tillage, 332 acres of grassed waterway, 200 grade stabilization structures and 4,000 feet windbreaks).

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Accelerated land treatment program not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation costs for land treatment.	$586,500
2.	Technical assistance	110,000
	Total	$696,500

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion on 116,000 acres of cropland from an average of 7.0 tons/acre/year to 3.0 t/a/y.
2. Improve water quality in streams by reducing sediment concentrations.
3. Decrease agricultural nutrient contributions to streams.
4. Increase quality of terrestrial wildlife habitat on 116,000 acres.
5. Improve quality of aquatic ecosystems.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Accelerated land treatment program not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation costs for land treatment.	$263,900	$322,600
2.	Technical assistance	-	110,000
	Total	$263,900	$432,600

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 27 jobs during the installation period.
2. Enhance visual quality of agricultural landscape on 116,000 acres.
3. Improve recreation activities in local such as boating, swimming and fishing.
4. Improve hunting on 116,000 acres.

PREFERRED PLAN

STUDY OBJECTIVE - Reduce flooding damages and poor drainage on 2,750 acres of cropland.

PLAN ELEMENT - Channel work 14 miles; Den Bleyker Drain-Allegan Co., 1.0 mile; Battle Creek-Eaton Co., 6.0 miles; Macatawa River-Ottawa Co., 7.0 miles, and 3 floodwater retarding structures.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/		
Reduce annual flood damages and increase efficiency on 2,750 acres of cropland.	$87,200	1. Installation costs	$513,000	$33,100
		2. Land rights	$154,700	10,000
		3. O. M. & R.		7,900
		4. Administration	$ 73,000	4,700
		Total		$55,700

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce flood hazard to wildlife along 14 miles of channel.
2. Increase grassland wildlife habitat in channel area by 52 acres.
3. Decrease woody wildlife habitat in channel area by 25 acres.
4. Degrade aquatic ecosystem on 14 miles of stream.
5. Increase water temperatures on 14 miles of stream.
6. Increase sedimentation during construction period.
7. Reduce cropland by 27 acres.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS		ADVERSE EFFECTS		Region	Rest of Nation
Reduce annual flood damages and increase efficiency on 2,750 acres of cropland.	$87,200	1. Installation costs	$513,000	$14,900	$18,200
		2. Land rights	$154,700	10,000	-
		3. O. M. & R.		7,900	-
		4. Administration	$73,000	1,200	3,500
		Total		$34,000	$21,700

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 23 jobs during the installation period.
2. Provide agricultural flood protection on 2,750 acres.
3. Change visual quality of the landscape along 14 miles of stream.

1/ Average annual.
2/ Amortized for 50-years @ 6 1/8 percent.

PREFERRED PLAN

STUDY OBJECTIVE - Provide public access to 285 miles of stream for recreation.

PLAN ELEMENT - Install 57 public access sites.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	
Provide 95,475 recreation days @ .75/day.	$71,600	1. Installation costs	$31,100
		2. Land rights	700
		3. O. M. & R.	24,100
		Total	$55,900

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Increase in traffic, noise, litter, fishing, hunting, trapping will put stress on fish, wildlife and plant communities along 285 miles of stream.
2. Increase sedimentation in 285 miles of stream during construction.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS		ADVERSE EFFECTS	Region	Rest of Nation
Provide 95,475 recreation days @ .75/day.	$71,600	1. Installation costs	$31,100	-
		2. Land rights	700	-
		3. O. M. & R.	24,100	-
		Total	$55,900	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce safety hazards of roadside parking and bridge fishing.
2. Provide local water based recreation on 285 miles of stream.
3. Create 22 jobs during the installation period.

1/ Average annual.
2/ Amortized for 50-years @ 6 1/8 percent.

PREFERRED PLAN

STUDY OBJECTIVE - Provide hunting opportunities on private land.

PLAN ELEMENT - Lease 122,000 acres hunting lands at county level by sale of permits to hunters.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/	
Provide 162,300 hunter days at 2.25/day/year.	$365,200	1. Lease costs	$183,000
		2. Administration	61,000
		Total	$244,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Increase in traffic, noise, litter, and hunting will put stress on wildlife and plant communities on 122,000 acres.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS	Region	1/ Rest of Nation
Provide 162,300 hunter days at 2.25/day/year.	$365,200	1. Lease costs	$183,000	-
		2. Administration	61,000	-
		Total	$244,000	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Provide 162,300 hunter days/year.
2. Provide $183,000 income to Basin landowners.
3. Increase safety hazard from increase in firearm use on 122,000 acres.
4. Create 13 jobs.

1/ Average annual.

PREFERRED PLAN

STUDY OBJECTIVE - Provide 105 miles of non-motorized recreation trails.

PLAN ELEMENT - Develop 70 miles of abandoned railroad rights-of-way; develop 35 miles of trail along rural roads, streams and state-owned land.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	
Provide 157,500 recreation days/year @ 1.50/day.	$236,300	1. Construction costs $1,540,000	$99,400
		2. Land rights $708,800	45,800
		3. O. M. & R.	77,200
		Total	$222,400

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Increase in traffic, noise, litter, and trail recreational activities will put stress on wildlife and plant communities along 105 miles of trail.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	Region	Rest of Nation
Provide 157,500 recreation days/year @ 1.50/day.	$236,300	1. Construction costs $1,540,000	$71,600	$27,800
		2. Land rights $708,800	33,000	12,800
		3. O. M. & R.	77,200	-
		Total	$181,800	$40,600

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Provide 157,500 local recreation days/year for trail activities.
2. Increase traffic, noise, and litter in area.
3. Create 45 jobs during the installation period.

1/ Average annual.
2/ Amortized 50-years @ 6 1/8 percent.

PREFERRED PLAN

STUDY OBJECTIVE - Reduce urban flood damage on 172 acres.

PLAN ELEMENT - Provide structural flood protection measures for Paw Paw Lake.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	
Reduction of average annual flood damage to existing property.	$44,600	1. Structural costs $300,000	$18,400
		2. Project administration $ 25,000	1,500
		Total $325,000	$19,900

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/		ADVERSE EFFECTS 1/ 2/	Region	Rest of Nation
Reduction of average annual flood damage to existing property.	$44,600	1. Structural cost $300,000	$4,200	$14,200
		2. Project administration $ 25,000	500	1,000
		Total	$4,700	$15,200

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 14 jobs during the installation period.
2. Improve health and safety for floodplain users on 172 acres.

1/ Average annual.
2/ Amortized for 100-years @ 6 1/8 percent.

PREFERRED PLAN

STUDY OBJECTIVE - Accelerate the treatment of livestock wastes on 181 farms.

PLAN ELEMENT - 65 holding tanks, 116 earth pits.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/ 2/

Reduce annual loss of nutrients from farms.

A. Nitrogen	- 169,100 lbs.	$49,000
B. Phosphorous	- 16,800 lbs.	9,600
C. Potassium	- 348,800 lbs.	34,900
Total		$93,500

ADVERSE EFFECTS 2/ 3/

1. Installation costs $2,166,500	$171,500
2. Technical assistance	17,200
3. O & M. Costs	34,300
Total	$223,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality by reducing nutrient concentrations in streams and lakes.
2. Improve quality of aquatic ecosystem.
3. Contain and utilize animal wastes on 181 farms.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/ 2/

Reduce annual loss of nutrients from farms.

A. Nitrogen	- 169,100 lbs.	$49,000
B. Phosphorous	- 16,800 lbs.	9,600
C. Potassium	348,800 lbs.	34,900
Total		$93,500

ADVERSE EFFECTS 2/ 3/

	Region	Rest of Nation
1. Installation costs $2,166,500	$42,900	$128,600
2. Technical assistance $ 216,700	-	17,200
3. O. & M. Costs	34,300	-
Total	$77,200	$145,800

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Create 86 jobs during the installation period.
2. Enhance visual quality of land and water in local areas.

1/ All benefits not evaluated.
2/ Average annual.
3/ Amortized 25-years @ 6 1/8 percent.

PREFERRED PLAN

STUDY OBJECTIVE - Reduce streambank erosion on 330 miles of stream.

PLAN ELEMENT - Erosion Control (Stabilize 157,300 feet of streambank, install 12,100 feet of rock riprap, install 148 acres grassed waterway, fence 198,100 channel from livestock, install 193 acres of buffer strips, install 25 drop inlet structures, plant 117 acres of trees, apply 73 acres of critical area treatment).

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation costs	$572,000
2.	Technical assistance	25,600
	Total	$597,600

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality for fish on 330 miles of stream by reducing sedimentation, nutrient runoff and water temperatures.
2. Improve wildlife habitat by planting permanent vegetation on 193 acres of channel bank.
3. Improve fish cover by increasing bank vegetation along 330 miles of streams.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation costs	$286,000	$286,000
2.	Technical assistance	12,800	12,800
	Total	$298,800	$298,800

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve fishery resources for recreation in watersheds that receive stream improvement.
2. Improve visual quality along 330 miles of stream.
3. Reduce maintenance for drainage on 330 miles of stream.
4. Create 24 jobs during the installation period.

PREFERRED PLAN

STUDY OBJECTIVE - Protect 65,200 acres of wetland from expansion of cropland and urban areas.

PLAN ELEMENT - Local wetland zoning.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS		ADVERSE EFFECTS	
NOTE: Not evaluated in monetary terms.		Wetland inventory and protection	$39,100

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Preserve 65,200 acres of wetland for wildlife habitat, groundwater recharge, runoff nutrient utilization, and floodwater storage.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS		ADVERSE EFFECTS		
			Region	Rest of Nation
NOTE: Not evaluated in monetary terms.		Wetland inventory and protection	$39,100	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Preserve visual quality of landscape on 65,200 acres.
2. Preserve 65,200 acres of wetland for production of game and non-game wildlife species used for recreation.
3. Continue production of insect pests from 65,200 acres of wetland.
4. Allow some wetlands to become safety hazards near urban developments.
5. Provide resource for development of outdoor classrooms.
6. Reduce landowners rights on 65,200 acres.

PREFERRED PLAN

STUDY OBJECTIVE - Enhance 43,000 acres of wetlands for waterfowl nesting.

PLAN ELEMENT - Install waterfowl nesting platforms in 11,300 acres of marsh and open water wetlands at a rate of one/5 acres. Install waterfowl nesting boxes in 22,600 acres of wooded and 9,100 acres of shrub wetland at a rate of one/20 acres.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

Installation costs $55,100

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Increase waterfowl production on 43,000 acres of wetland.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

	Region	Rest of Nation
Installation costs	$55,100	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Increase waterfowl production on 43,000 acres of wetland.

PREFERRED PLAN

STUDY OBJECTIVE - Improve upland wildlife habitat on 154,700 acres.

PLAN ELEMENT - Make one acre openings at a rate of 5/section in each of approximately 280 sections that have more than 50 percent of their area in forest; underplant coniferous trees in 565 sections with more than 25 percent of their area in forest land. Plant 32-96 ac/section; plant conifer and/or shrub hedgerows in 210 sections with 50 percent or more of their area in cropland and less than five percent in wetlands; manage 33,700 acres of utility rights-of-way for wildlife habitat; use minimum or no tillage on 75,400 acres of corn land.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation costs	$ 952,900
2.	Technical assistance	47,600
	Total	$1,000,500

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Increase quantity and quality of wildlife habitat on 154,700 acres.
2. Reduce consumption of non-renewable energy resources by reduced vegetative maintenance on 33,700 acres of rights-of-way and 75,400 acres of cropland.
3. Increase availability of cropland food for wildlife on 75,400 acres.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation costs	$ 714,700	$238,200
2.	Technical assistance	-	47,600
		$ 714,700	$285,800

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Improve wildlife resources for recreation on 154,700 acres.
2. Enhance visual quality on 33,700 acres of rights-of-way.
3. Increase frequency of wildlife on roads and railroads.
4. Increase fire and snow hazards in 6,300 acres of road rights-of-way.
5. Increase wildlife use on 75,400 acres of cropland.
6. Create 44 jobs during installation.

PREFERRED PLAN

STUDY OBJECTIVE - Protect 291 miles of stream corridors.

PLAN ELEMENT - Local greenbelt zoning.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS	
NOTE: Not evaluated in monetary terms.	Corridor delineation and protection	$87,300

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

Preservation of 291 miles of stream corridor which include important habitats for fish, wildlife and plants; several archeological and historical sites; and several sites which contain one or more rare plant species.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	ADVERSE EFFECTS		
		Region	Rest of Nation
NOTE: Not evaluated in monetary terms.	Corridor delineation and protection	$87,300	-

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Restrict future development on 21,130 acres.
2. Reduce landowner rights on 21,130 acres.
3. Maintain visual quality of landscape on 21,130 acres.

PREFERRED PLAN

STUDY OBJECTIVE - Protect 157,400 acres of prime agricultural land from other uses.

PLAN ELEMENT - Implement Farmland and Open Space Preservation Act.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Protection of prime cropland was not evaluated in monetary terms.

ADVERSE EFFECTS

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Preserve 157,400 acres of agricultural wildlife habitat.
2. Prevent irreversible loss of 157,400 acres of prime cropland.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Protection of prime cropland was not evaluated in monetary terms.

ADVERSE EFFECTS

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Maintain existing visual quality of the agricultural landscape on 157,400 acres.
2. Stabilize agricultural industry and support services.
3. Insure production of agricultural wildlife for recreation on 157,400 acres of prime land.
4. Protect this valuable resource for future generations.

PREFERRED PLAN

STUDY OBJECTIVE - Manage and enhance an additional 66,100 acres of forest land to increase fiber growth and yield and to improve environmental conditions.

PLAN ELEMENT - Increase forest land managed for "maximum fiber" from 18,800 acres to 30,300 acres; forest land managed for "multiple use" from 95,500 acres to 150,100 acres; and application of timber stand improvement measures from 28,800 acres to 59,800 acres.

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Annual sawtimber growth increased approximately 18 percent. Not evaluated in monetary terms.

ADVERSE EFFECTS

1.	Installation	$1,085,000
2.	Technical assistance	332,000
	Total	$1,417,000

ENVIRONMENTAL QUALITY ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion rates, increase wildlife habitat values, improve growth, health and vigor of forest land.
2. Moderate short term disturbances while applying improvement measures.

REGIONAL DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

NOTE: Annual sawtimber growth increased approximately 18 percent. Not evaluated in monetary terms.

ADVERSE EFFECTS

		Region	Rest of Nation
1.	Installation	$ 217,000	$868,000
2.	Technical assistance	232,000	100,000
		$ 449,000	$968,000

SOCIAL WELL-BEING ACCOUNT

BENEFICIAL AND ADVERSE EFFECTS

1. Small increase in hunter days.
2. Create 50 jobs during installation.
3. Increase regional awareness of importance of forested lands and their management.
4. Protect local forest industries from drastic raw material supply reductions.

SUMMARY PREFERRED PLAN 1/
National Economic Development Account

Beneficial effects: 2/	
The value to users of increased outputs of goods and services.	
1. Flood Prevention and Drainage	
a. Urban	$ 44,600
b. Agricultural	87,200
Subtotal	$131,800
2. Recreation	
a. Recreation Trails	$236,300
b. Hunting	365,200
c. Access Sites	71,600
Subtotal	$673,100
3. Reduced Loss of Nutrients from Farms	$ 93,500
Total Beneficial Effects	$898,400

Adverse effects: 2/	
The value of resources required for a plan.	
1. Channel Work and Floodwater Retarding Structures	
a. Project Installation	$ 51,500
b. O & M	7,900
c. Land Rights	10,000
2. Recreational Development	
a. Project Installation	$313,500
b. O. M. & R.	101,300
c. Land Rights	46,500
3. Reduced annual Loss of Nutrients from Farms	
a. Project Installation	$171,500
b. O & M	34,300
c. Technical Assistance	17,200
4. Project Administration	$ 67,200
Total Adverse Effects	$820,900
Net Beneficial Effects	$77,500

1/ The following study objectives were not evaluated in monetary terms, wetland enhancement for waterfowl nesting, protect stream corridors, protect wetland from expansion of cropland and urban areas, reduce streambank erosion, reduce erosion on cropland, improve upland wildlife habitat and forest land management. Total cost of these objectives is $3,893,100.

2/ Average annual.

SUMMARY PREFERRED PLAN
Environmental Quality Account

Beneficial and adverse effects:

A. Quality consideration of water, land, and air resources.

1. Reduce erosion on 116,000 acres of cropland from an average of 7.0 tons/acre/year to 3.0 t/a/y.
2. Improve water quality in streams by reducing sediment concentration.
3. Decrease agricultural nutrient contributions to streams.
4. Increase water temperatures on 14 miles of stream.
5. Increase sedimentation on 285 miles of stream during construction period.
6. Reduce cropland by 27 acres.
7. Improve water quality by reducing nutrient concentrations in streams and lakes.
8. Contain and utilize animal wastes on 181 farms.
9. Preserve 65,200 acres of wetlands for wildlife habitat, groundwater recharge, runoff nutrient utilization, and floodwater storage.
10. Reduce consumption of non-renewable energy resources by reduced vegetative maintenance on 33,700 acres of rights-of-way and 75,400 acres of cropland.

B. Biological resources and selected ecosystems.

1. Increase quality of terrestrial wildlife habitat on 116,000 acres.
2. Improve quality of aquatic ecosystems.
3. Reduce flood hazard to wildlife along 14 miles of channel.
4. Increase grassland wildlife habitat in channel area by 52 acres.
5. Decrease woody wildlife habitat in channel area by 25 acres.
6. Degrade aquatic ecosystem on 14 miles of stream.
7. Increase in traffic, noise, litter, fishing, hunting, trapping, and trail recreational activities will put stress on fish, wildlife and plant communities along 285 miles of stream, 105 miles of trail and on 122,000 acres.
8. Improve quality of aquatic ecosystem.
9. Improve water quality for fish on 330 miles of stream by reducing sedimentation, nutrients runoff and water temperatures.
10. Improve wildlife habitat by planting permanent vegetation on 193 acres of channel bank.
11. Improve fish cover by increasing bank vegetation along 330 miles of stream.

SUMMARY PREFERRED PLAN (Continued)
Environmental Quality Account

12. Increase waterfowl production on 43,000 acres of wetland.
13. Preserve 157,400 acres of agricultural wildlife habitat.
14. Preservation of 291 miles of stream corridor which included important habitats for fish, wildlife and plants.
15. Increase quantity and quality of wildlife habitat on 154,700 acres.
16. Increase availability of cropland food for wildlife on 75,400 acres.

C. Irreversible or irretrievable commitments.

Prevent irreversible loss of 157,400 acres of prime cropland.

SUMMARY PREFERRED PLAN 1/
Regional Development Account

Beneficial effects:	(Average Annual)
The value of increased output of goods and services to users residing in the region.	
1. Flood Prevention and Drainage	
a. Urban	$ 44,600
b. Agricultural	87,200
Subtotal	$131,800
2. Recreation	
a. Recreation Trails	$236,300
b. Hunting	365,200
c. Access Sites	71,600
Subtotal	$673,100
3. Reduced Loss of Nutrients from Farms	$ 93,500
Total Beneficial Effects	$898,400

Adverse effects:	Region (Average Annual)	Rest of Nation (Average Annual)
The value of resources contributed to achieve the output.		
1. Channel work and dikes		
a. Project Installation	$ 19,100	$ 32,400
b. O. M. & R.	7,900	-
c. Land Rights	10,000	-
2. Recreational Development		
a. Project installation	$285,700	$ 27,800
b. O. M. & R.	101,300	
c. Land Rights	33,700	12,800
3. Reduced Loss of Nutrients From Farms		
a. Project Installation	$ 42,900	$ 128,600
b. O & M	34,300	-
c. Technical Assistance	-	17,200
4. Project Administration	$ 62,700	$ 4,500
Total Adverse Effects:	$597,600	$223,300
Net Beneficial Effects:	$300,800	$-223,300

1/ The following study objectives were not evaluated in monetary terms : wetland enhancement for waterfowl nesting, protect stream corridors, protect wetland from expansion of cropland and urban areas, reduce streambank erosion, reduce erosion on cropland, improve upland wildlife habitat and forest land management. ' Total cost of these objectives is $3,893,100.

SUMMARY PREFERRED PLAN
Social Well-Being Account

Beneficial and adverse effects:

A. Real Income Distribution

1. Create 348 jobs during the installation period.
2. Provide $183,000 income to Basin landowners.

B. Life Health and Safety

1. Enhance visual quality of agricultural landscape on 116,000 acres.
2. Provide agricultural flood protection on 2,750 acres.
3. Change visual quality of the landscape along 14 miles of stream.
4. Reduce safety hazards of roadside parking and bridge fishing.
5. Increase safety hazard from increase in firearm use on 122,000 acres.
6. Improve health and safety for flood plain users on 172 acres.
7. Enhance visual quality of land and water in local areas.
8. Improve visual quality along 330 miles of streams.
9. Preserve visual quality of landscape on 65,200 acres.
10. Continue production of insect pests on 65,200 acres of wetland.
11. Allow some wetlands to become safety hazards near urban development.
12. Provide resource for development of outdoor classrooms.
13. Reduce landowners rights on 65,200 acres of wetland.
14. Maintain existing visual quality of the agricultural landscape on 157,400 acres of prime agricultural land.
15. Stabilize agricultural industry and support services.
16. Restrict future development, reduce landowner rights, and maintain visual quality of landscape on 21,130 acres of stream corridor.
17. Enhance visual quality on 33,700 acres of rights-of-way.
18. Increase frequency of wildlife on roads and railroads.
19. Increase fire and snow hazards in 6,300 acres of road rights-of way.

C. Recreational Opportunities

1. Improve hunting on 116,000 acres.
2. Provide local water based recreation on 285 miles of stream.
3. Provide 162,300 hunter days/year.
4. Provide 157,500 local recreation days/year for trail activities.
5. Improve fishery resources for recreation on watersheds that receive stream improvement.
6. Preserve 65,200 acres of wetland for production of game and non-game wildlife species used for recreation.
7. Insure production of agricultural wildlife for recreation on 157,400 acres of prime land.

SUMMARY COMPARISON OF PLANS
Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin

Accounts	PLAN A Nat'l.Economic Development	PLAN B Preferred	PLAN C Environmental Quality	Plan B Minus Plan A	Plan B Minus Plan C
A. NATIONAL ECONOMIC DEVELOPMENT					
Beneficial Effects ($)	1,473,000	898,400	121,400	-574,600	777,000
Adverse Effects ($)	1,089,390	820,900	289,500	-268,490	531,400
Net Beneficial Effects ($)	383,610	77,500	-168,100	-306,110	245,600
B. ENVIRONMENTAL QUALITY (Beneficial and Adverse Effects)					
1. Areas of Natural Beauty					
Protect and/or improve areas for:					
Natural & scenic values (acres)	0	86,330	128,755	86,330	-42,425
Prime agricultural land (acres)	0	157,400	157,400	157,400	0
2. Quality Consideration of Water, Land, and Air Resources					
a. Reduce streambank erosion (miles)	0	330	430	330	-100
b. Reduce soil loss (acres)	116,000	177,000	234,000	61,000	-57,000
c. Remove land from crop production (acres)	45	27	252	-18	-225
d. Increase sedimentation during construction (miles)	1,004	629	430	-375	199
e. Reduce consumption of nonrenewable energy resources on land maintenance (acres)	0	109,100	212,300	109,100	-103,200
f. Contain & utilize animal wastes (farms)	0	181	235	181	-54
3. Biological Resources & Selected Ecosystems					
a. Disrupt aquatic ecosystem (miles)	14	14	0	0	14
b. Improve water quality and fish habitat (miles)	0	330	430	330	-100
c. Establish or improve upland wildlife habitat (acres)	116,000	300,000	490,000	184,000	-190,000
d. Protect wetland wildlife habitat (acres)	0	65,200	101,600	65,200	-36,400
e. Protect upland wildlife habitat (acres)	0	178,530	184,550	178,530	-6,020
f. Change riparian wildlife habitat: (acres)					
grassland (increase)	52	52	252	0	-200
brushland (decrease)	25	25	0	0	25
cropland (decrease)	27	27	252	0	-225
g. Produce noise, litter & stress on wildlife & plant communities (acres)	255,760	123,320	0	-132,440	123,320
h. Produce noise, litter & stress on fish, wildlife & plant communities (stream miles)	980	285	0	-695	285
4. Irreversible or irretrievable commitment of resources					
Commit land to channels (acres)	52	52	0	0	52

SUMMARY COMPARISON OF PLANS (continued)
Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin

Accounts	PLAN A Nat'l Economic Development	PLAN B Preferred	PLAN C Environmental Quality	Plan B Minus Plan A	Plan B Minus Plan C
C. REGIONAL DEVELOPMENT					
Income					
Beneficial Effects ($)	1,473,000	898,400	121,400	-574,600	777,000
Adverse Effects ($)	984,980	597,600	100,200	-387,380	497,400
Net Beneficial Effects ($)	488,020	300,800	21,200	-187,220	279,600
D. SOCIAL WELL-BEING					
1. Provide agriculture flood protection (acres)	3,320	2,750	0	-570	2,750
2. Provide recreation (recreation visits)	876,120	415,275	0	-460,845	415,275
3. Improve land for hunting & other recrea. uses of wildlife (acres)	116,000	313,700	519,900	197,700	-206,200
4. Enhance visual quality of landscape (acres)	116,000	335,900	518,500	219,900	-182,600
5. Enhance visual quality of landscape (mi. of stream)	14	316	430	302	-114
6. Provide access to streams for water based recreation (miles)	980	285	0	-695	285
7. Provide income to basin landowners from hunting land leases ($1.50/ac)	381,000	183,000	0	-198,000	183,000
8. Increase safety hazards from firearms (acres)	254,000	122,000	0	-132,000	122,000
9. Provide urban flood protection (acres)	172	172	0	0	172
10. Maintain (preserve) visual quality of landscape.	0	243,730	287,500	243,730	-43,770
11. Insure production of wetland insects pests (acres)	0	65,200	101,600	65,200	-36,400
12. Reduce stream maintenance for drainage and flood control (miles)	14	344	0	330	344
13. Reduce landowner rights (acres)	0	86,330	128,755	86,330	-42,425
14. Increase fire and snow hazard on road R-O-W (acres)	0	6,300	12,200	6,300	-5,900

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN

Capability of Alternatives to Satisfy Needs

Study Objectives	Units	Quantity	NED Plan		Preferred Plan		EQ Plan	
			Needs Satisfied	Remaining Needs	Needs Satisfied	Remaining Needs	Needs Satisfied	Remaining Needs
1. Reduce cropland erosion	Acres	116,000	116,000	-	116,000	-	116,000	-
2. Reduce Agr. Flooding and drainage damage	Dollars	107,200	107,200	-	87,200	20,000	-	107,200
3. Provide additional public access	Sites	196	196	-	57	139	-	196
4. Provide additional hunting land	Acres	254,000	254,000	-	122,000	132,000	-	254,000
5. Provide managed recreation trails	Miles	140	140	-	105	35	-	140
6. Reduce urban flooding damage	Dollars	44,600	44,600	-	44,600	-	-	44,600
7. Treat livestock waste	Farms	235	-	235	181	54	235	-
8. Reduce streambank erosion	Miles	430	-	430	330	100	430	-
9. Protect wetland wildlife habitat	Acres	101,600	-	101,600	65,200	36,400	101,600	-
10. Enhance wetland wildlife habitat	Acres	103,000	-	103,000	43,000	60,000	103,000	-
11. Improve upland wildlife habitat	Acres	300,900	-	300,900	154,700	146,200	300,900	-
12. Protect stream corridors	Miles	374	-	374	291	83	374	-
13. Protect prime agricultural land	Acres	157,400	-	157,400	157,400	-	157,400	-
14. Manage and enhance additional forest land	Acres	66,100	66,100	-	66,100	-	66,100	-

CHAPTER X

Implementation

CHAPTER X

IMPLEMENTATION

A plan has been developed to protect, enhance, and prudently use the water and land resources in the Basin. Many citizens in the Basin share a sense of urgency about this Plan as they see their resources degraded by misuse. They believe something must be done now before it is too late. Successful implementation of the Plan will require a "plan" of action or strategy. The following suggestions are offered to the citizens groups who ultimately will determine whether the Plan is implemented or not.

SUGGESTIONS FOR IMPLEMENTATION

The Citizens Advisory Council should act as the overall sponsor of the Plan. Although having only the power of persuasion, this body can explain the various elements of the Plan and the ways in which it will benefit the entire Basin. The Council can assist in the application for funding of projects and act to coordinate work involving more than one county.

The County Task Forces should act as the primary sponsors of the county plans. They should enlist the support of conservation groups and service clubs in addition to local units of government and soil conservation districts to implement individual elements in the county plans.

Implementation should be undertaken in phases. The first phase could take care of the emergencies and most pressing needs determined by the Task Forces, in each county. These will vary between counties, but may include the protection of natural and scenic streams, wetlands, and prime croplands, The second phase could aim at reducing the deficiencies in public access sites, recreation trails, and hunting land.

The elements in this Plan should be included in the comprehensive county plans. The plans for counties which have already been completed should be reviewed and adjusted to comply with the County Task Force's plans.

A publicity program should be formulated and undertaken by the Council and the Task Forces to educate people about the Plan. People should be aquainted with the benefits to be achieved in order to secure their support for the Plan and to encourage their participation in implementation.

Means for financing the various elements in the Plan should be explored. Funds may be obtained under various Federal, State and local programs, revenue sharing programs, and the issuing of bonds. Development by private enterprises should also be encouraged.

AVAILABLE PROGRAMS

An implementation strategy should be developed for each element in each county plan. To assist in this, Federal and State programs that could be used for implementation are reviewed here.

REDUCE EROSION ON CROPLAND TO AN ACCEPTABLE LEVEL

Technical and financial assistance is available through the United States Department of Agriculture's programs described in Chapter VI (page 6-5).

REDUCE AGRICULTURAL FLOOD DAMAGE AND IMPROVE CROPLAND DRAINAGE ON EXISTING CROPLAND

The Michigan Drain Code provides a statutory procedure for governmental group action. The establishment of new drains and improvement of existing drains depends on the initiative of landowners. Procedural steps can be obtained from the various county drain commissioners.

Financial and technical assistance is available under the Watershed Protection and Flood Prevention Act (Public Law 83-566, 1954, as amended), administered by the Soil Conservation Service. The watershed projects must be sponsored by a local organization such as the drainage district. They must also be sponsored by the soil conservation districts.

PROVIDE ADDITIONAL PUBLIC ACCESS TO STREAMS

Several programs offer assistance. In Berrien and Van Buren Counties public acquisition and development of access sites may be

accomplished through the Resource Conservation and Development Program, administered by the Soil Conservation Service. Assistance is also available through the Land and Water Conservation Act and the Dingell-Johnson Enabling Act, both administered by the Michigan DNR.

PROVIDE ADDITIONAL LAND FOR HUNTING

There are no Federal or State programs that provide funds for leasing land for public hunting. A State or local program could be developed to use hunting permit revenue to lease land from cooperating landowners.

PROVIDE MANAGED RECREATIONAL TRAILS

Financial assistance, on a matching fund basis is available from the Land and Water Conservation fund. This is a Federal program of the U.S. Bureau of Outdoor Recreation, administered in Michigan by the Department of Natural Resources.

FIGURE 10-1 HORSEBACK RIDING ALONG A MANAGED TRAIL

REDUCE URBAN FLOOD DAMAGE

Technical and financial assistance is available from the Resource Conservation and Development Program, or the Watershed Protection and Flood Prevention Program (P.L. 566), administered by the Soil Conservation Service.

PROVIDE TREATMENT OF LIVESTOCK WASTES

Technical and financial assistance is available through the United States Department of Agriculture's programs described in Chapter VI (page 6-7).

REDUCE STREAMBANK EROSION

The same programs that offer assistance for reducing erosion on cropland and providing additional access sites also may be used to reduce streambank erosion.

PROTECT AND ENHANCE WETLAND WILDLIFE HABITAT

Assistance is available through the State and Federal programs described in Chapter VI (page 6-8).

IMPROVE UPLAND WILDLIFE HABITAT

Assistance is available through the USDA program described in Chapter VI (page 6-8).

PROTECT AND MANAGE STREAM CORRIDORS

The Michigan Natural Rivers Act of 1970 authorizes the Michigan Natural Resources Commission to designate natural rivers possessing one or more outstanding values as wilderness, wild scenic or county scenic rivers. These rivers would be permanently managed for the preservation and enhancement of these values. This program is administered by the Department of Natural Resources--Division of Land Resource Programs.

Citizens groups may want to consider a more local approach to protecting their streams. One or a combination of the following methods may be used:

1. Greenbelt and flood plain zoning at township or county level.
2. Enactment and enforcement of strong health codes.
3. Acquisition of riverfront property by local public agencies.
4. Formation of local river protection association.

PROTECT PRIME AGRICULTURAL LAND

The Farmland and Open Space Preservation Act of 1974 administered by the Division of Land Resources Programs of the Michigan Department of Natural Resources covers both farmland and open space. It provides tax relief to an owner of farmland as long as he agrees to keep it substantially undeveloped. More specifically, the owner pays property taxes as before, but any amount by which the tax exceeds seven percent of the owner's household income becomes a tax credit applied to the State income tax.

A landowner who is interested in applying files an application with the local governing body, i.e., city or village, the township if there is an adopted zoning ordinance, or the county if the township does not have a zoning ordinance. The local governing body has 45 days within which to consult with various public agencies, such as the soil conservation district or county or regional planning commission, and either approve or reject the application. If approved, the application is forwarded to the Department of Natural Resources, Division of Land Resources Programs. If rejected, the applicant may appeal directly to the Department. The Department has 60 days within which to approve or reject an application.

MANAGE AND ENHANCE ADDITIONAL FOREST LAND

Technical and financial assistance is available through the State and Federal programs described in Chapter VI (page 6-9).

CHAPTER XI

Impacts of USDA Programs

CHAPTER XI

IMPACTS OF USDA PROGRAMS

A substantial part of the Preferred Plan can be implemented through USDA programs if personnel and Federal cost sharing funds are available. The actual accomplishments depend largely on the priorities established by the soil conservation districts and the interest of the landowners involved.

To determine the portion of the Plan that may be accomplished, meetings were held with District Directors and Soil Conservation Service field personnel throughout the Basin. In many cases, district's long range programs were changed to more closely reflect the desires of the County Task Forces in solving initial problems, thus implementing part of the Preferred Plan. Projected accomplishments are shown in Table 11-1. The impacts of these accomplishments are compared with the total impact of the Preferred Plan in Table 11-2.

Appropriate USDA programs to assist in implementation of this plan are described in Chapters 6 and 10 as noted in Table 11-1. Additional information on specific programs can be obtained from the local Soil Conservation Service office in each county.

TABLE 11-1--CAPABILITY OF USDA PROGRAMS TO IMPLEMENT PREFERRED PLAN

Study Objective	Plan	Implementation With USDA Programs	Page Reference to Appropriate USDA Program
1. Reduce cropland erosion	116,000 acres	40,000	6-5
2. Reduce agricultural flooding	2,750 acres	-	10-2
3. Provide public access to streams.	57 sites	-	-
4. Provide additional land for hunting.	122,000 acres	-	-
5. Provide managed recreation trails.	105 miles	-	-
6. Reduce urban flood damage.	44,600 dollars	-	10-4
7. Provide treatment of livestock waste.	181 farms	67	6-7
8. Reduce streambank erosion.	330 miles	35	10-4
9. Protect wetland wildlife habitat	65,200 acres	1,300	6-8
10. Enhance wetland wildlife habitat	43,000 acres	5,700	6-8
11. Improve upland wildlife habitat	154,700 acres	6,100	6-8
12. Protect and manage stream corridors	291 miles	-	-
13. Protect prime agricultural land	157,400 acres	-	-
14. Manage and enhance forest land	66,100 acres	-	6-9

TABLE 11-2--USDA PROGRAMS--SUMMARY OF IMPACTS

Account	Preferred 1/ Plan	USDA Programs
A. NATIONAL ECONOMIC DEVELOPMENT		
Beneficial Effects ($)	898,400	34,600
Adverse Effects ($)	820,900	82,500
Net Beneficial Effects ($)	77,500	(-) 47,900
B. ENVIRONMENTAL QUALITY (Beneficial & Adverse Effects)		
1. Areas of Natural Beauty		
Protect prime agricultural land, wetland, and land along natural and scenic streams (acres)	243,730	
2. Quality Consideration of Water, Land and Air Resources		
a. Reduce streambank erosion (miles)	330	35
b. Reduce soil loss (acres)	177,000	40,000
c. Remove land from crop production (acres)	27	
d. Increase sedimentation during construction (miles)	629	
e. Reduce consumption of nonrenewable emergency resources on land maintenance (acres)	109,100	
f. Contain & utilize animal wastes (farms)	181	67
3. Biological Resources & Selected Ecosystems		
a. Degrade aquatic ecosystem (miles)	14	
b. Improve water quality & fish habitat (miles)	330	35
c. Establish or improve upland wildlife habitat (acres)	375,180	51,800
d. Preserve wetland wildlife habitat (acres)	65,200	1,300
e. Change riparian wildlife habitat: (acres)		
grassland (increase)	52	
brushland (decrease)	25	
cropland (decrease)	27	
f. Produce noise, litter & stress on wildlife and plant communities (acres)	123,320	
h. Produce noise, litter & stress on fish, wildlife & plant communities (stream miles)	285	
4. Irreversible or irretrievable commitment of resources		
a. Preserve prime agr. land (acres)	157,400	
b. Commit land to channels or levees (acres)	52	
C. REGIONAL DEVELOPMENT		
1. Income		
Beneficial Effects ($)	898,400	
Adverse Effects ($)	537,000	
Net Beneficial Effects ($)	361,400	
2. Employment		
Increased jobs during installation	348	
D. SOCIAL WELL-BEING		
1. Provide agricultural flood protection (acres)	2,750	
2. Provide recreational opportunities (recreational visits)	415,275	
3. Improve land for hunting & other recrea. uses of wildlife (acres)	313,700	51,800
4. Enhance visual quality of landscape (acres)	335,900	47,400
5. Enhance visual quality of landscape (mi. of stream)	316	35
6. Provide access to streams for water-based recreation (miles)	285	
7. Provide income to Basin landowners from hunting land leases ($)	183,000	
8. Increase safety hazards from firearms (acres)	122,000	
9. Provide urban flood protection (acres)	172	
10. Maintain (preserve) visual quality of landscape	178,530	1,300
11. Insure production of wetland insects pests (acres)	65,200	1,300
12. Reduce landowner rights (acres)	21,130	
13. Increase fire & snow hazard on road R-O-W (acres)	6,300	

Appendices

APPENDIX A

SEDIMENTATION ANALYSIS

The concentrations of sediment in the Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin were expressed quantitatively by utilizing a systematic routing and computation procedure. This procedure involved several steps which utilized both proven and empirical relationships.

The first step in the sedimentation analysis was computation of erosion rates on the land. This was done by utilization of the *Universal Soil Loss Equation*, Agricultural Handbook 282, USDA, Agricultural Research Service, 1965. The computation procedures described in Handbook 282 utilizes data on rainfall energy, soil types, length and steepness of slope, crop and other cover conditions, and conservation and other management practices.

The average annual erosion rates for the watersheds (shown on Table 3-7) range from 1.0 to about 4.0 tons per acre per year. Erosion rates for single storm events were also computed. The storms evaluated were single storm events that are equalled or exceeded every one-, two-, five-, ten-, and twenty-year period. Erosion rates for single storm events range from 0.2 to 1.4 tons per acre. Variation in erosion rates between the watersheds range from 0.2 to 0.8 tons per acre for the one-year storm and from 0.4 to 1.4 tons per acre for the twenty-year storm.

The evaluation of sediment delivery ratios (the proportion of eroded soil from the land delivered by the stream system to a downstream point) was the second step in the sedimentation analysis. Ratios vary from 0.02 to 0.08, meaning that the delivery of eroded soil to the lower end of each of the eight watersheds varies from two to eight percent of the soil eroded from the land. A major factor causing differences in sediment delivery ratios is the wide variation in average soil permeability among the watersheds.

Consideration of the runoff of rainfall is the third step in the sedimentation analysis. Average annual runoff among the

watersheds ranges from 10.7 to 15.8 inches. Runoff from single storm events range from 0.4 inches to 3.4 inches. Variations in runoff among the watersheds range from 0.4 to 1.5 inches for a one-year storm event and from 1.0 to 3.4 inches for a twenty-year storm event.

The analysis of the three components described above provides the data needed to determine sediment concentrations. The runoff from the watersheds for the various storm events was expressed as tons of water. These values were paired with the tons of soil eroded and delivered downstream by the corresponding storm events. By constructing frequency arrays of storm events, the percent of time that suspended sediment concentrations are at or above various levels was expressed.

APPENDIX B

Projections Methodology And Analysis

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APPENDIX B

PROJECTIONS METHODOLOGY AND ANALYSIS

The evaluation of resource development plans is based on comparing what is expected to occur with development to what is expected in its absence. This permits a clear identification of the benefits and costs associated with a plan. Projections of future conditions are therefore basic to planning.

Chapter VI presents future agricultural conditions that are expected to occur without a development plan. It is emphasized that these conditions are not predictions but rather are projections based on certain reasonable assumptions such as those regarding future food and fiber requirements, income levels, technology, and environmental concerns. Alternative assumptions reflecting different views, for example, on food requirements or changes in farm technology expected to occur without a development plan, result in an alternative set of projections. Chapter IV presents such an alternative.

The purpose of this appendix is to describe the methodology underlying the projections used in this report and to demonstrate the impacts of alternative assumptions, many involving development actions, on the use of Basin resources.

METHODOLOGY

Linear programming (L.P.) is the mathematical technique used to analyze the supply potential of the land resource. The resource is divided into one-acre units, each of which have the potential to produce a package of interrelated products. Included in the cropland package are the major crops of corn, soybeans, wheat, oats, and hay. Additional products are soil loss, wildlife habitat, recreation potential, and hunter-days. The permanent pasture package does not include the first four crops; the forest land package replaces the five crops with poletimber and sawtimber. The amount of each product produced is a function of: 1) the quality of the soil resource; 2) the use of that resource; and 3) the management practices employed. Using various assumptions regarding these factors as constraints, the L.P.'s

objective function operates to minimize the cost of producing the major food or fiber products. As noted above, other associated products will also be produced along with the major product.

The inputs to the L.P. consist of a detailed inventory of the major uses and quality of the land resource, the types and extent of management strategies, yield coefficients for each strategy on a particular land unit, current and future requirements (demands) for the major crops, poletimber, and sawtimber, costs of production and of development activities.

LAND INVENTORY

SOILS

The basic unit of analysis in the L.P. is the soil management group (SMG). SMG's are groupings of basic soils that a) produce similar crops and pasture plants with similar management practices, b) require similar soil conservation practices under the same vegetative cover, and c) have comparable potential productivity. The acre extent of the SMG's, their conservation needs, and the use to which they are put is based on the *Michigan Conservation Needs Inventory, 1968* (CNI). Twenty-eight SMG's were defined for cropland and pasture. These were further grouped for forest land into five aggregated SMG's (ASMG).

CONSERVATION NEEDS

Soil conservation needs were originally identified in terms of their use during the CNI inventory. The *Michigan Forest Survey, 1966* was used to complement the CNI in specifying these forest land needs. The cropland need categories in this study are:

1. adequately treated
2. adequately treated; drained
3. needs management change
4. needs drainage
5. needs change to pasture or forest

Pasture needs are:

1. adequately treated
2. needs improvement
3. needs change to forest

Forest land needs are:

1. adequately treated
2. needs timber stand improvent (TSI)

MAJOR USES

Recognition of the heterogeneous quality of the Basin's land resource, the need to analyze soil loss on a watershed basis, and the availability of most data for whole counties led to defining only four subareas with mixed political-hydrologic boundaries (Figure B-1).

Crop production and acreage data were obtained from the Michigan Crop Reporting Service and the U.S. Bureau of the Census. They were merged into the hydrologically oriented soils information of the CNI to allocate crops to subareas, SMG's, and soil conservation treatment needs. This crucial step resulted in a detailed description of the land resource and its current use. The Forest Service provided similar data by forest type (coniferous, oak-hickory, elm-ash-cotton-wood, maple-beech-birch, and aspen-birch) and stand size (non-stocked, seeding-sapling, poletimber, sawtimber).

MANAGEMENT STRATEGIES

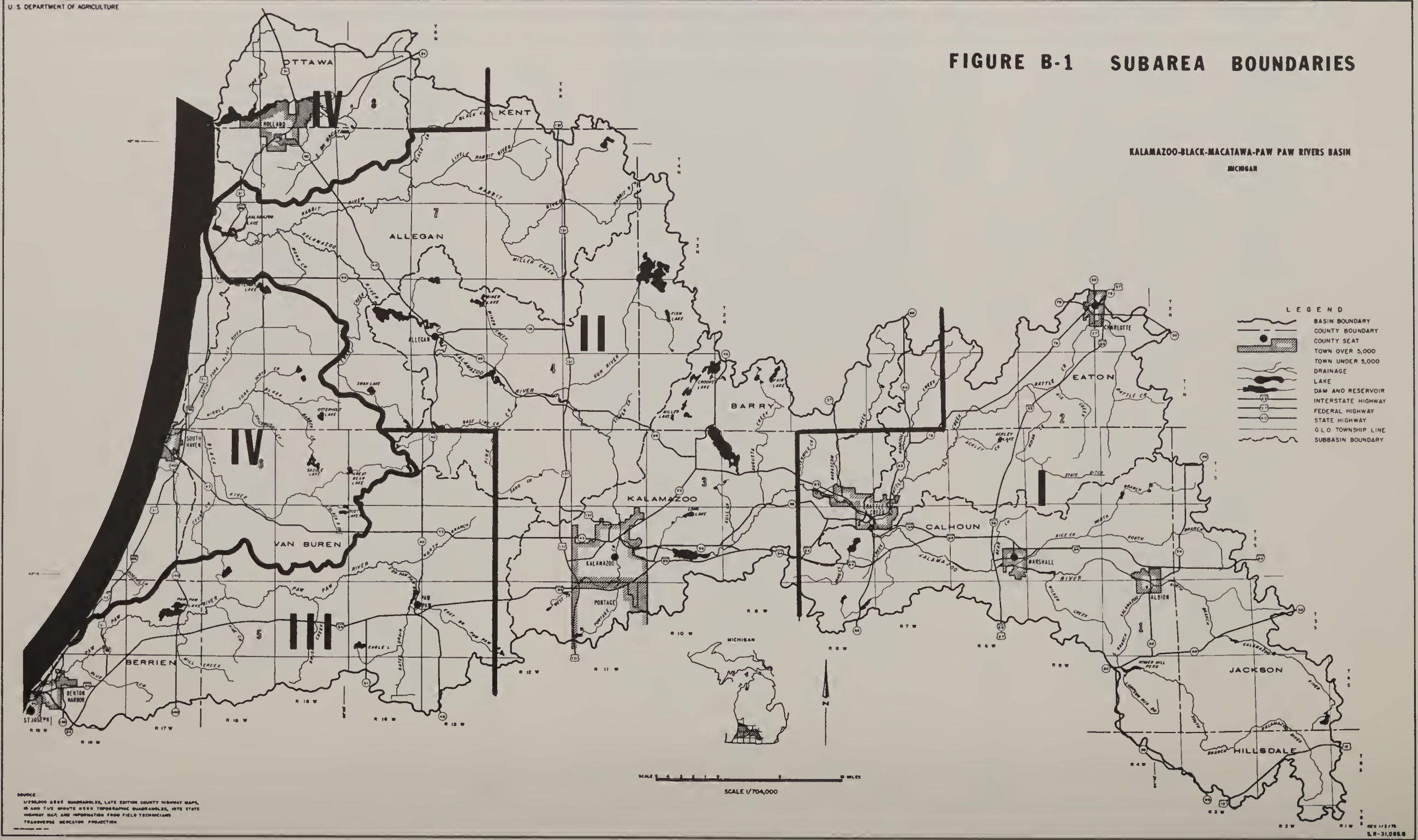
Erosion is a major source of water pollution. In addition to causing sedimentation, it transports fertilizers and pesticides to waterways. Cropland strategies in this study are structured around soil conserving techniques. The alternatives are:

1. conventional tillage; plowing is done in the fall
2. conventional tillage; plowing is done in the spring
3. minimum tillage; plowing is done in the spring; planting is done in wheel tracks
4. no tillage; the seedbed is prepared by breaking the soil with a coulter or single chisel and seed is planted in same operation

U. S. DEPARTMENT OF AGRICULTURE

FIGURE B-1 SUBAREA BOUNDARIES

KALAMAZOO-BLACK-MACATAWA-PAW PAW RIVERS BASIN
MICHIGAN



SOURCE
1/250,000 BASE QUADRANGLES, LATE EDITION COUNTY HIGHWAY MAPS, 15 AND 7½ MINUTE USGS TOPOGRAPHIC QUADRANGLES, 1972 STATE HIGHWAY MAP, AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION

REV 1/22/79
S.R-31,088.6

5. utilizing the less erosive SMG's for row crops, the more erosive SMG's for small grains or hay.

Permanent pasture strategies include continuous grazing and rotational grazing. In the former, animals are allowed to graze at will throughout the season. In the latter, fields are fenced and grazed on a rotation basis.

Forest strategies are:

1. maximum fiber production: harvest is made at 10-year intervals; release, weeding, and thinning are done as needed; utilization is intensive

2. environmental emphasis: there is no harvesting and only minimal control of fire, insects, and disease

3. multiple use: harvest is made at 20-year intervals; there is some grazing; erosion is minimized; and cultural practices are performed

4. current management: harvest is made on an ad hoc basis; there are no cultural practices; grazing is light; utilization is poor; this strategy is currently found on small woodlots.

PRODUCT YIELD

Crop yields were developed for each of the 5 major crops cited above. They are a function of SMG, conservation need, and tillage practice. Estimated yields for corn, soybeans, hay and oats in 1990 were expected to be 120 percent of present levels; in 2020, they are expected to be 140 percent. Wheat yields are projected to increase to 130 percent and 150 percent in the two time periods.

On forest land, annual fiber growth yields that vary by SMG, forest type, stand size, and management strategy were estimated. For many reasons, such as diverse ownership objectives, only a part of the growth is available for production. As this proportion could not be estimated, production was assumed to equal growth.

Per acre soil loss was computed using the Universal Soil Loss Equation. The equation stated algebraically is A=RKLSCP where A is soil loss per acre; R is a rainfall factor; K is a soil erodability coefficient; L and S are the length and gradient of the soil;

C refers to the cropping rotation used; and P is the erosion-control factor for terracing, contouring, stripcropping, or farming with straight rows up and down the slope.

Wildlife biologists estimated the relationships between vegetative cover (forest type, pasture, row crop, small grain, idle, etc.) and the ability of an acre to supply food needs of 3 species--deer, rabbit, and squirrel. This potential supply capacity was converted into hunter-day numbers by assuming a certain proportion of the population could be safely harvested annually, an average hunter success ratio, and an average number of days for a hunting trip.

Whereas each of the previous product outputs are expressed in physical units such as bushels or tons, two indices--wildlife habitat and outdoor recreative potential--were developed to indicate relative rather than absolute change. The wildlife index system indicates relative acre value for habitat. It varies by vegetative cover, management strategy, and SMG slope and drainage condition. The highest value for land cover is 1.00 (for idle cropland; nonstocked and adequately treated forest land); the lowest value is 0.10 (for sod and truck crops). Acreages with steep slopes and some poor drainage conditions are considered better for habitat than flat, well-drained acreages.

An example calculation for an acre of row crops, fall plowed using conventional tillage methods on SMG 23E (erosive soils, classes 2 and 3) serves to illustrate the methodology. SMG 23E has a 2-6 percent slope and is well-drained. Hence, the slope-drainage index is 0.3. The land cover-management index is also relatively low, 0.2. Assigning a double value to the cover index, compared to the composite wildlife habitat index is 0.233: $(0.2 \times 2) + (0.3 \times 1) \div 3$. If cover, strategy, or SMG cultivated to produce this acre of row crops changes, relative index value would change. A comparison of the index value in two different situations together with differences in cost of production, acres of land used in production and left idle, and other variables gives the analyst a basis to evaluate such a non-market change.

The same methodology was used to reflect an area's relative potential for a variety of outdoor recreation activities such as hunting, hiking, snowmobiling, snow-shoeing, sightseeing, birdwatching, and camping. The index values associated with cover, strategy, slopes, and drainage were developed separately and so differ from those of the wildlife index.

This brief discussion only outlines the methods used to develop yield coefficients for the products available on each acre. Complete information can be obtained from the Economic Research Service. The relationships are summarized in Table B-1.

TABLE B-1--PRODUCT YIELD RELATIONSHIPS

Dependent Variables	Independent Variables (Number)
Major crop yield	SMG (28), conservation need (5), tillage (4)
Pasture yield	SMG (28), conservation need (3), type of grazing (2)
Wood fiber yield	ASMG (5), stand size (4), stand condition (2), management (4)
Erosion rate	
Cropland	SMG (28), tillage (4), control practice (2)
Pasture	SMG (28)
Forest	ASMG (5), stand size (4), stand condition (2), management (4)
Wildlife habitat)	
Recreation potential)	Cropland: SMG (28), crop (6), tillage (4) Pasture : SMG (28), type grazing (2) Forest : ASMG (5), ecosystem (5),
Hunter days)	stand size (4), Management (4)

PRODUCTION COSTS

An automated budgeting system is used to compute cropland management costs for the L.P. The system assembles data in four major components: 1) farm equipment operation costs; 2) fixed seed, fertilizer, chemical costs; 3) variable inputs, either fixed (seed, herbicides, insecticides) or based on yields (fertilizer); 4) report features. The Soil Conservation Service provided data on the size and type of equipment and the inputs used in the Basin. Machine costs per hour were calculated using methods proposed in the *Midwest Farm Planning Manual*. Machine costs may vary due to soil practice and tillage. Report features allow specifying inputs used of seed, pesticides, lime, fuel, and labor as well as machine cost and total cost.

Forest land production costs were developed for the harvesting of poletimber and sawtimber. They vary by stand size, ecosystem, and soil group. There is no variation due to management type or stand condition.

All current cost relationships on both cropland and forest also apply to 1990 and 2020.

DEVELOPMENT ACTIVITIES

Several development activities are possible on cropland: drainage where there is an identified need; application of a package of land treatment measures where there is a "management need"; installation of terraces and/or contour plowing separately from the land treatment program. The basic land treatment program has two options:

1. install some combination of contour stripcropping, waterways, and windbreaks to reduce erosion at a cost.

2. install the erosion control measures and assume an improvement in managerial abilities to reduce erosion and to raise crop yields (from the "management need" level to the "adequately treated" level). The cost of this option in the L.P. is the same as the first option. The additional costs associated with the higher level of management are certainly real but could not be quantified. The two levels of managerial ability are compared in Table B-2.

TABLE B-2--CROPLAND MANAGEMENT LEVELS

Item	Management Need	Adequate Management
Crop rotations	planned but not followed	adequate
Lime/fertilizer	used, but not adequate	applied properly
Crop residues	used, but not for the greatest benefit	properly managed
Planting/harvesting	not properly timed	properly timed
Plants/acre	inadequate number	proper number
Weed, insect control	not properly controlled	good control

No development activities are included on permanent pasture. Forest land development includes timber stand improvement (TSI) measures to make a stand "adequately" treated. TSI is only a need on land managed under multiple use or current management strategies.

If managed for maximum fiber growth, all measures are assumed to have been applied. As no harvesting is possible under the environmental emphasis strategy, no TSI is ever applied.

FUTURE PRODUCT REQUIREMENTS

The L.P. is designed to meet future (1990 and 2020) food and fiber requirements at the least cost. Basin requirements for corn, soybeans, oats, wheat, hay, poletimber, and sawtimber were derived from Michigan's share of the national OBERS Series E' projections. See Chapter VI for some of the assumptions underlying these projections.

No attempt was made to project future requirements for habitat, hunter-days, or recreation potential as this would have forced the study team to assign its own subjective values to these products.

CONSTRAINTS ON RESOURCE USE

Without constraints on the use of resources, the L.P. is free to minimize production cost in any way possible. Thus, if one subarea has more productive soils than the others, an unconstrained L.P. would shift all production possible to that subarea in meeting major product requirements. At the same time, resources in other subareas would be idled. Such a shift, solely for the purpose of lowering costs, may not be realistic for many reasons such as immobility of farm investments, personal desires to remain on one's farm, and uncertainty about the future.

Constraints are therefore placed on resource use in order to introduce reality into the L.P. solution. In order to incorporate the social, institutional, and economic climate of the Basin, most constraints are directly tied to the current situation. Some of the major baseline constraints on cropland are:

1. projected (1990 and 2020) requirements for corn, soybeans, wheat, oats, and hay. Requirements for specialty and minor crops were handled outside of the L.P. model.

2. in 1990, production of row crops and small grains in any one subarea may range from 80% to 120% of that currently

produced; for 2020, the range is widened to 70%-130%. Hay production is allowed to range from 95% to 105% in 1990 and from 90% to 110% in 2020. This constraint recognizes productivity differences between subareas and the tendency of the agricultural industry to respond to them.

3. in 1990, row crop production may range from 80% to 160% on the best (classes 1-2) soils and 60% to 100% on the poorest (classes 4-6) soils. Due to lower small grain demands in 1990 (row crop demands are expected to rise), 1990 small grains production may range from 70% to 110% on the best soils, from 40% to 80% on the poorest soils. Hay production is allowed to range from 55% to 105% on the best soils, from 55% to 100% on the poorest soils. The purpose of these constraints is to recognize: a) the tendency of farm operators to farm the most productive soils more intensively and the poorest soils less; and, b) the changing relationships between future crop requirements and yields and the need to utilize currently idle land.

4. the L.P. was instructed to put 66%, 24%, and 10% of rotation cropland acreage into conventional, minimum, and "no" tillage, respectively, for the 1990 solution. This compares to current percentages of 75%, 25%, and 1%. An extension of this trend is recognized by the percentages used in 2020: 50%, 30%, and 20%. These constraints recognize that farmers will probably call upon reduced tillage methods to meet the problems of rising labor costs, growing environmental concerns particularly those dealing with water pollution, and to increase production efficiency.

5. forest land was completely constrained for the baseline. That is, the U.S. Forest Service specified the number of acres to be found in every cell currently, in 1990, and 2020. Multiplication of acres by yields gave the product output and cost. The L.P. was thus not used to develop the baseline, although it was used for several alternative future situations.

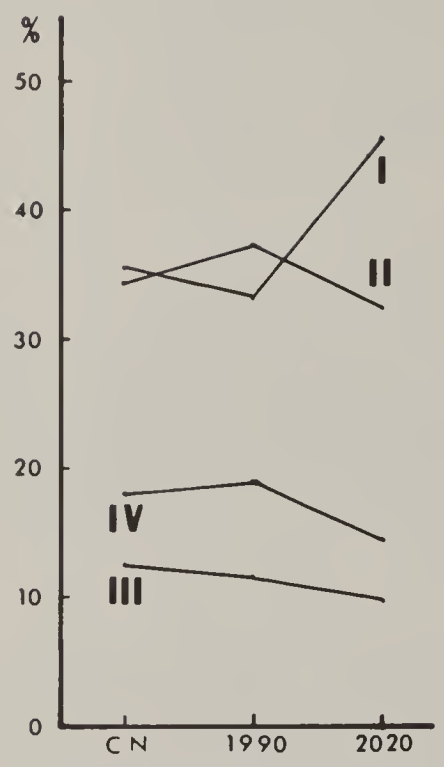
ANALYSIS

BASELINE CONDITIONS

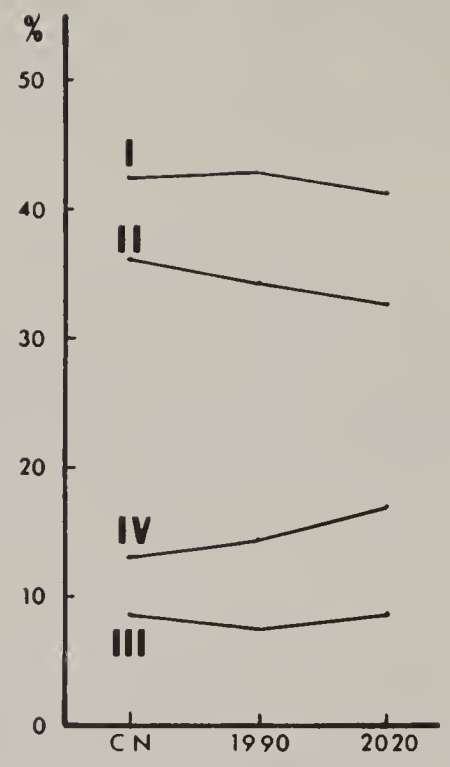
The L.P. model evaluates the Basin's ability to meet future product requirements at minimum cost, always subject to resource constraints. Chapter VI compares current conditions to those expected to occur in 1990 and 2020 without implementation of this plan. These "no development" conditions are a "baseline" to which any development plans can be compared.

The main report does not analyze changes that are expected to occur in each subarea. These are shown in Figure B-2. Only a Basin-wide analysis was used for forest land since subarea comparisons were not considered significant. Since the same crop production budgets were used in all subareas, the relative changes reflect the resource base differences in each subarea. Figure B-2 suggests several significant shifts may occur in the relative importance of Basin subareas over the 50-year planning period. Subarea I appears to be increasing its share of Basin corn acreage and decreasing its share of open and idle cropland. These two cropland uses are quite important in the Basin, accounting for 25 percent and 27 percent of the total cropland acreage respectively. The subareas's share of soybean production is expected to fall, but even in 2020 this use will account for only 3 percent of total cropland. Subarea II is expected to become slightly less important in wheat acreage, and considerably less so in oats. These changes are not particularly significant, however, since these two crops should become less important in the Basin as a whole. By 2020 they are expected to account for only 3 percent of cropland acreage. Subarea IV is expected to experience a strong expansion in its relative share of Basin soybean acres, some expansion in oats, wheat, and idle land, and a slight reduction in corn acreage. To reiterate an earlier statement, it was assumed production costs were the same in all subareas. Therefore, these relative shifts in cropland use reflect the quantity and quality distribution of the soil resource.

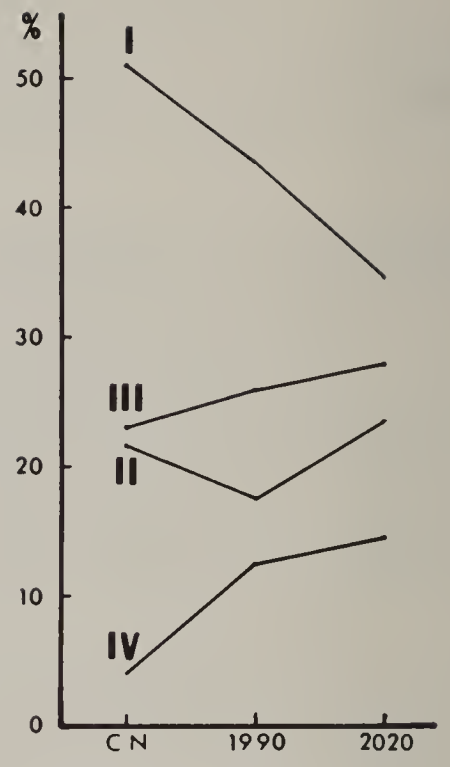
Figure B-3 shows a decline in erosion levels for all subareas. Subarea I has the highest rates, a not surprising result since it has a relatively large portion of its land in row crops. The reduction in erosion is due primarily to the greater use of minimum and "no" tillage practices. It is also expected that the more erosive soils will be gradually taken out of row crop production and put into small grains and hay.



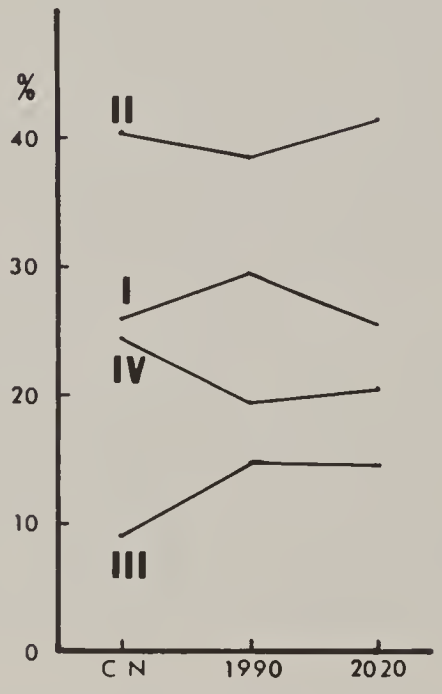
Subarea Share of
Basin Corn Acres



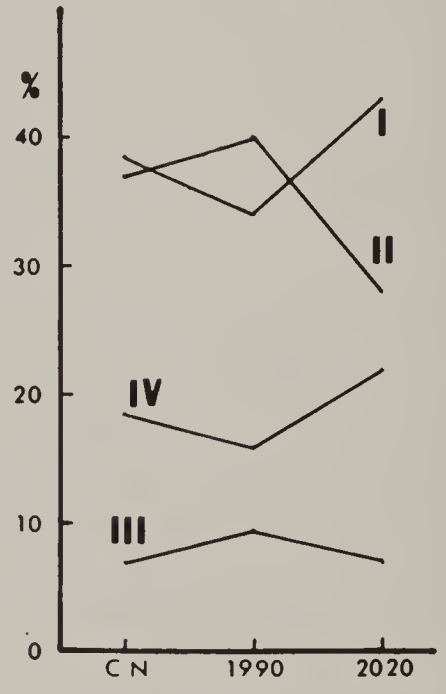
Subarea Share of
Basin Wheat Acres



Subarea Share of
Basin Soybean Acres

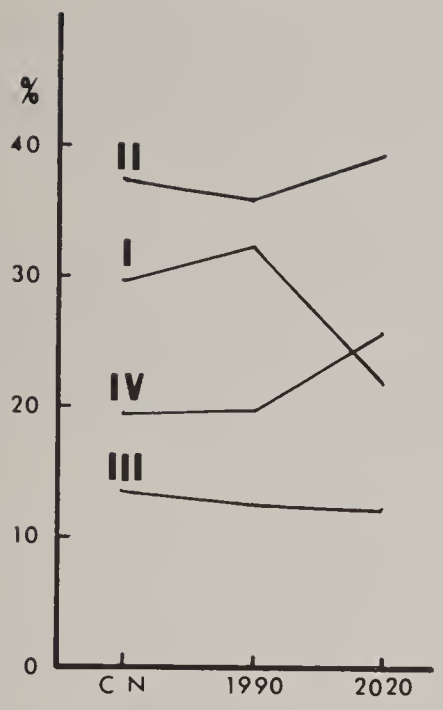


Subarea Share of
Basin Hay Acres

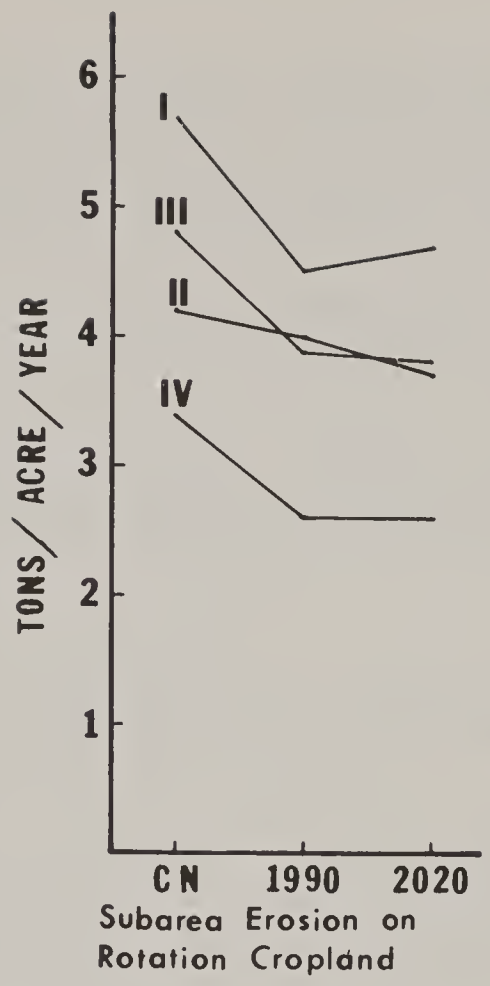


Subarea Share of
Basin Oats Acres

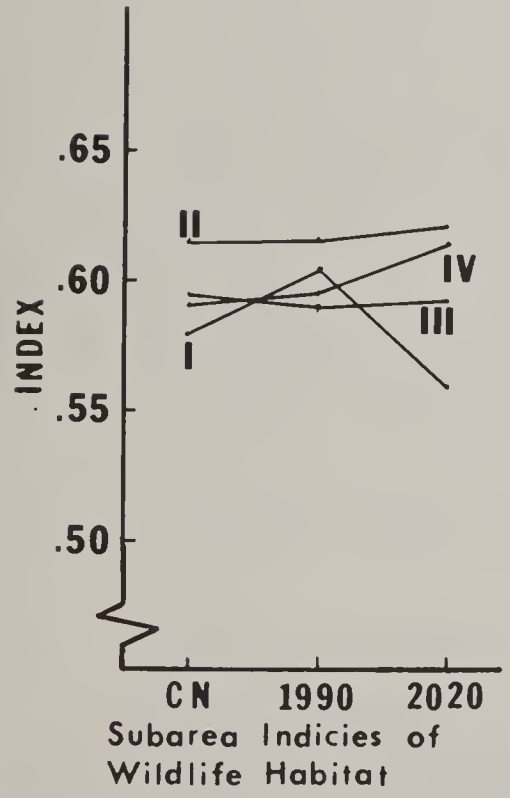
FIGURE B-2 COMPARISON OF SUBAREA
CHANGES FOR VARIOUS CROPS



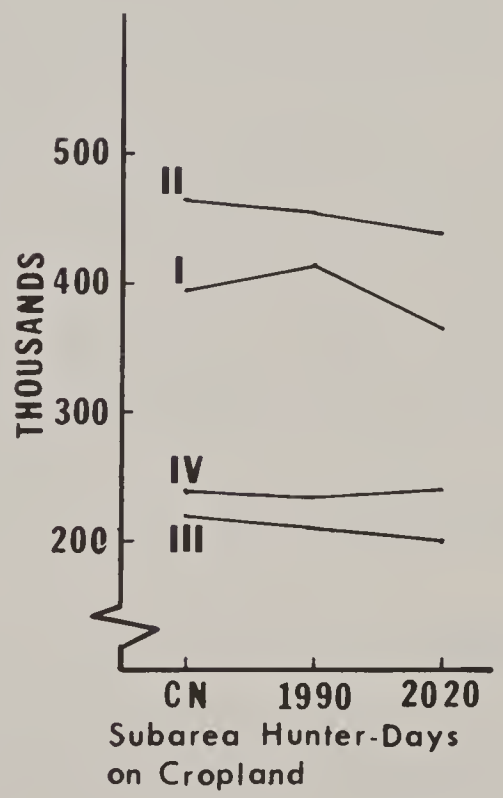
Subarea Share of Basin Open and Idle Cropland Acres



Subarea Erosion on Rotation Cropland



Subarea Indicies of Wildlife Habitat



Subarea Hunter-Days on Cropland

FIGURE B-3 COMPARISON OF SUBAREA CHANGES FOR ENVIRONMENTAL CONCRENS

The potential supply of hunter-days is expected to show only a slight decline over the 50-year period for all but Subarea I. The shift in this area is tied directly to the increase in idle acres (with its high potential productive capacity for animals) between the present and 1990 but a consequent fall between 1990 and 2020.

The wildlife habitat index is expected to show little change for Subareas II and III over the 50-year period. It rises substantially in IV and declines in I. Both movements correspond to changes in open and idle acreage. Similar movements should occur in the index of outdoor recreation potential not shown here.

ALTERNATIVES TO BASELINE CONDITIONS

Many alternative futures can be developed by varying the independent variables affecting product yields and/or by changing the constraints that bound the optimization procedure of the L.P. In addition to the Current Normal and two baseline runs (1990 and 2020), six alternative cropland runs and four forest land runs were done for 1990. The cropland runs were developed with the Soil Conservation Service staff and had the general objectives of reducing erosion and otherwise enhancing the environment. The purposes of the forest land runs were to evaluate methods of increasing sawtimber growth, improving the efficiency of poletimber growth, and enhancing the environment. Comparisons of the runs allow the analyst to ascertain the sensitivity of resource outputs to alternative assumptions about the future and to suggest the effects of policy changes. The major assumptions of the cropland runs are discussed below and summarized in Table B-3.

ALTERNATIVE 4

ASSUMPTIONS

Produce 1990 requirements using current technology. Maintain yields, fertilizer and pesticide application, and tillage practices at current levels. Table B-4 compares each of the cropland futures with the 1990 baseline. With the exception of Future 6, the desired future described in Chapter IV, crop requirements are the same for all runs.

TABLE B-3--SUMMARY OF CROPLAND AND FOREST LAND FUTURES - 1990

Future	Purpose 1/	Major Assumptions
Cropland		
4	Use current technology	Maintain current yields, use of fertilizer, and extent of minimum and "no" tillages.
1	Reduce erosion	Apply land treatment and improve farm management.
2	Reduce erosion	Apply land treatment and improve management or increase use of minimum and "no" tillage.
3	Reduce erosion and chemical use	Apply land treatment holding management constant or increase use of "no" tillage. Restrict growth in yields.
5	Reduce erosion and chemical use	Apply land treatment holding management constant together with increase in minimum and "no" tillages. Restrict growth in yields.
6	Reduce erosion and chemical use. Produce desired future food requirements.	Same as future 5.
Forest Land		
1F	Increase sawtimber growth	Put more acreage under maximum fiber and multiple use. Apply TSI to these acres.
2F	Increase sawtimber growth	Apply TSI to all sawtimber acres.
3F	Produce poletimber at least cost	Shift acres among strategies and/or apply TSI
4F	Produce sawtimber growth at least cost.	Shift acres among strategies and/or apply TSI.

1/ A common purpose to 1-5 was to produce 1990 crop requirements derived from national OBERS projections at least cost. Crop requirements of 6 were derived from Michigan Department of Natural Resources projections.

TABLE B-4--SUMMARY COMPARISON OF CROPLAND BASELINE AND ALTERNATIVE FUTURES, 1990

Cropland	Units (1000)	Baseline	Alternative Futures (As % of 1990 Baseline) 4	1	2	3	5	6
Major crop acreage 1/	ac.	598.1	120	91	91	101	106	112
Open and idle	ac.	297.1	59	113	117	98	87	56
Production cost 1/	$1000	33.1	113	97	95	101	105	121
Conventional tillage	ac.	279.1	146	94	29	38	97	115
Minimum tillage	ac.	104.0	130	93	260	113	131	160
No tillage	ac.	42.9	13	72	55	493	131	160
Fertilizers	tn.	57.6	95	102	102	100	99	111
Erosion on rotation cropland	tn/yr	1666.0	171	65	64	40	75	78
Erosion on cropland, pasture, forest	tn/yr	1866.0	163	67	68	46	77	80
Contour stripcropping 2/	ac.	-	-	25.9	15.1	7.5	26.7	40.0
Waterways 2/	ac.	-	-	0.5	0.4	0.2	0.5	0.8
Windbreaks 2/	ft.	-	-	92.8	40.4	30.8	101.0	133.4
Wildlife habitat	index	0.605	90	102	107	107	99	94
Recreation potential	index	0.604	93	102	106	103	99	94
Hunter-days	no.	1316	91	103	106	106	99	93

1/ For all corn, wheat, oats, soybeans, and hay.
2/ Measures in the land treatment program. Figures in 1990 Alternatives are absolutes; not percentages of the 1990 Baseline.

IMPACTS

The impacts of meeting 1990 food requirements with current technology are shown in Table B-4. As might be expected, unchanging crop yields and erosion control practices in the face of higher food requirements leads to a sharp rise in cropland acreage, a fall in idle land, higher total production costs, and much higher erosion levels. The need to intensively crop more land, including relatively poor soils, and to leave less land idle, leads to significantly lower values for wildlife habitat, recreation potential, and hunter-days.

ALTERNATIVES 1 AND 2

ASSUMPTIONS

Alternative 1 assumes production of 1990 crop requirements but restricts cultivated cropland erosion to the T-value (a maximum soil loss value that is consistent with maintaining long-term productivity) on all SMG's. Do this by applying the land treatment program to those SMG's with a "management need." Assume that along with these erosion control measures, the managerial abilities applied to the soil resource are improved such that yields increase from the "need treatment" level to the "adequately treated" level. Maintain the distribution of conventional, minimum and no tillage acerage to that expected in the 1990 baseline.

The purposes of alternative 2 are the same as those of 1 but are obtained by allowing the L.P., rather than the analyst, to choose between a) the land treatment program plus management improvements (hence yield increases) and b) increasing the acre extent of "no" tillage and minimum tillage practices while contracting conventional tillage.

IMPACTS

In addition to producing 1990 food requirements at least cost, the purpose of Runs 1 and 2 is to reduce erosion. The methods used--the land treatment program and tillage changes--are the same. The difference in impacts may result from the sole orientation of cutting costs (Run 2) to an orientation which recognizes that technology can only shift at a limited rate (Run 1).

In reaching essentially the same erosion levels (a one-third reduction over that of the baseline), both Runs use much less cropland due to the higher yields associated with managerial improvements. Whereas both involve the installation of treatment measures, the L.P. in Run 2 relies more heavily than Run 1 on minimum tillage, the least costly alternative. "No" tillage acreage, a more expensive method than conventional or minimum tillage due to the application of costly herbicides is cut by one-half. Conventional tillage, because of its relatively high soil loss, is reduced to 29 percent of its extent in the 1990 baseline. Production cost of the five major crops is below that of the baseline for both runs, but the L.P. free choice Run 2 is the more efficient. Minimum tillage and idle lands are relatively favorable for wildlife and outdoor recreation and hence these environmental indices rise in both runs, particularly in Run 2.

ALTERNATIVES 3 AND 5

ASSUMPTIONS

Alternative 3 assumes production of 1990 crop requirements but limits erosion to the T-value and restricts the growth in use of fertilizer and pesticides. Obtain the limit on erosion by allowing the L.P. to choose between: a) the land treatment program (but no management improvements and hence no increases in crop yields); and, b) increased "no" tillage practices. Hold the minimum tillage percentage at its 1990 baseline level. Also, restrict cropland use of the more erosive SMG's to below current levels. Simultaneously obtain restricted growth in chemicals by allowing yields to increase only 10 percent above current levels. (The baseline assumes a 20 percent increase. This cuts the growth in chemical use since use is linearly related to yield. At the same time, the increased use of "no" tillage and decreased use of conventional tillage should result in greater use of chemicals).

The purposes of alternative 5 are the same as those of Run 3 but they are obtained by: a) setting minimum tillage at 30 percent of cultivated cropland (24 percent in the 1990 baseline) and "no" tillage systems at 15 percent (10 percent in the baseline); and b) applying the land treatment program, but no managerial improvements, to cropland SMG's with a "management need"; c) limiting the use of erosive SMG's; and, d) limiting yields to 10 percent above current levels.

IMPACTS

Runs 3 and 5 have dual purposes-to reduce soil loss and to restrict the growth in agricultural chemical use. The land treatment program is applied in both, as in Runs 1 and 2. However, as no managerial improvements are included, yields do not rise. Since Runs 1 and 2 include the yield benefit but no costs due to these improvements, the costs of 1 and 2 are not comparable with those of 3 and 5.

In Run 3, the L.P. freely chooses to put heavy emphasis on "no" tillage, an extremely effective way to cut soil loss, and relatively little on treatment measures. The more costly conventional tillage is cut to 38 percent of the 1990 baseline level. Run 5 attempts to recognize other than purely economic motivations. It fixes minimum and "no" tillage at levels greater than the baseline but which seem reasonably attainable. It is not as effective as Run 3 in reducing erosion, is limited to less dramatic shifts in tillage, and installs more treatment measures than Run 3. Only Run 3 makes a notable change, an increase, in the environmental indicators.

ALTERNATIVE 6

The Desired Future Run 6 differs from Run 5 only in higher crop requirements for small grains and hay, and insignificant reductions in row crop demands. Chapter IV also discusses this desired future. Other assumptions are the same. Not surprisingly, cropland acreage is greater and idle acreage smaller than in 5. This shift in land use results in notably lower environmental indices.

MAJOR ASSUMPTIONS OF FOREST LAND ALTERNATIVES

Since the resource base is unable to meet the sawtimber requirements projected in the baseline, alternative 4F below includes requirements artifically lowered to the growth capability level of the resource. This permits use of the L.P. optimizing procedure.

Alternative 1F

Increase sawtimber growth to the extent possible by a) shifting sawtimber acres from current management to maximum fiber or multiple use while maintaining the maximum fiber multiple use acre ratio of the baseline; b) applying TSI to these new maximum fiber and multiple use acres.

Alternative 2F

Increase sawtimber growth by applying TSI to all sawtimber acres.

Alternative 3F

Produce 1990 poletimber growth at least cost by letting the L.P. a) shift acres between management strategy, and/or b) apply TSI.

Alternative 4F

Produce exogenously reduced 1990 sawtimber demands at least cost by allowing the L.P. to choose between a) shifting acres among management strategies, and b) TSI.

Table B-5 compares the four forest land alternatives to the 1990 baseline. Runs 1F and 2F used the computer only as an accounting device since the Basin was unable to raise sawtimber growth to meet requirements. This precluded the use of L.P. Application of TSI on sawtimber only (2F) was able to increase growth 2 percent. Costs rose 4 percent, however. TSI plus shifting acres from current management to maximum fiber and multiple use (Run 1F) was more effective in increasing sawtimber growth (it rose 18 percent) and more efficient (costs rose only 8 percent). The environmental indicators in Run 1F are consistently more favorable than the 1990 baseline.

In Run 3F, the L.P. was allowed to choose between management strategy changes and TSI on poletimber acres, whichever was cheaper, to minimize the cost of producing the baseline quantity of poletimber. In minimizing cost, the L.P. shifted a large number of acres into the high yield, low cost maximum fiber strategy. Since production was not to exceed the baseline, acreage in the no-fiber-production environmental emphasis strategy rose considerably. No TSI was applied as it is more expensive than shifting strategies. The net reduction in cost of this run was insignificant. The strategy shift did result in notable improvements in each of the environmental variables, particularly soil loss which was lowered 12 percent.

Run 4F, with the same purpose for sawtimber as for poletimber in Run 3F, achieved it with similar shifts of sawtimber acreage. Note that as with Run 3F, the main impact was not on costs but on more acres in maximum fiber and environmental emphasis, less on multiple use and current management, and on enhanced environmental indicators.

TABLE B-5--SUMMARY COMPARISON OF FOREST LAND BASELINE AND ALTERNATIVE FUTURE, 1990

Forest Land	Units (1000)	Baseline	Alternative Futures (% of 1990 Baseline) 1F	2F	3F	4F
Poletimber growth	cunits	86.6	100	100	100	100
Sawtimber growth	cunits	22.9	118	102	100	98
Maximum fiber strategy	acres	18.8	152	100	559	373
Environmental emphasis strategy	acres	34.1	100	100	181	164
Multiple use strategy	acres	95.5	149	100	99	88
Current management strategy	acres	263.3	79	100	57	77
Production cost (Poletimber and sawtimber) *	dollars	1700.2	108	104	99	99
Poletimber needing TSI	acres	64.4	100	100	100	100
Sawtimber needing TSI	acres	13.1	9	0	100	100
Wildlife habitat	index	0.665	103	100	105	102
Recreation potential	index	0.533	105	100	105	102
Hunter-days	number	2449	104	100	104	103
Erosion	tons	115.1	93	102	88	91

* Since no relationship could be specified between growth and production cost, these production cost figures are valid by assuming production equals growth.

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APPENDIX C

Water Quality At Selected Stream Locations

CONTENTS

APPENDIX C

WATER QUALITY AT SELECTED STREAM LOCATIONS

INTRODUCTION

Nineteen stations in eight counties were selected on streams located within the Kalamazoo, Black, Paw Paw, and Macatawa River Basins, (Figure 5-4 and Table C-1). In all cases the sites were selected to assess water quality in upstream areas.

A one-year sampling program was designed to include different annual flow regimes. Surface water grab samples were collected eight times between July 9, 1975 and March 4, 1976. Sampling periods were selected based on previous flow records. Two sampling runs were made at each of two high flow periods, one medium flow period, and one low flow period. Thirty parameters were measured at each sampling run.

Benthic macroinvertebrate communities were assessed for comparisons with the limited water chemistry data and evaluation of present water quality at four sampling sites. Sediments from three stations were analyzed for ten heavy metals and twenty synthetic hydrocarbons.

TABLE C-1--WATER QUALITY SAMPLING LOCATIONS

Station Number	Stream	Location	Section	Township	County	Parameters Sampled*
1	Blue Creek	Hicks Road	9	Benton	Berrien	1,3
2	Paw Paw River,So. Branch	County Road 665	35	Waverly	Van Buren	1,
3	Black River, So. Branch	66th Street	29	Geneva	Van Buren	1,
4	Black River, Middle Branch	70th Street	32	Casco	Allegan	1,
5	Black River, North Branch	103rd Avenue	30	Casco	Allegan	1, 2
6	Swan Creek	115th Avenue	29	Alley	Allegan	1,
7	Rabbit River	133rd Avenue	9	Manlius	Allegan	1, 3
8	Little Rabbit River	140th Ave & 32nd St.	21	Salem	Allegan	1
9	Macatawa River	96th Avenue	36	Holland	Ottawa	1, 2, 3
10	Battle Creek	Brookfield Road	28	Eaton	Eaton	1
11	Indian River	Butterfield Hwy.	33	Walton	Eaton	1, 2
12	Rice Creek	20 Mile Road	16	Marengo	Calhoun	1
13	Kalamazoo, North Branch	Bath Mills Road	5	Concord	Jackson	1
14	Wanadoger Creek	Pennfield Road	21	Pennfield	Calhoun	1
15	Wabascon Creek	M-89	28	Befford	Calhoun	1
16	Augusta Creek	EF Avenue E	27	Ross	Kalamazoo	1
17	Base Line Creek	Jefferson Road	21	Otsego	Allegan	1
18	Gun River	10th Street	17	Gun Plains	Allegan	1
19	Gates Drain, W. Branch Paw Paw River	60th Avenue	23	Paw Paw	Van Buren	1, 2

*1 = Water chemistry
2 = Macroinvertebrates
3 = Sediment Chemistry

METHODS

SURFACE WATER CHEMISTRY

Water chemistry was sampled eight times throughout one year at all 19 stations. Two samples were taken one week apart during each flow period. Low flow was in July, medium-flow in September-October, and high-flow in November-December and February-March. The flow was measured with each sampling. A steel tape measure was lowered to the water surface from a designated bridge mark at each station. This measurement was recorded and the discharge in cubic feet per second (cfs) was computed from the SCS prepared flow curve graphs.

Separate water samples were collected for metals, nutrients, phenols, bacteria and general chemistry with the appropriate preservation techniques. Nutrients for which determination were made were: soluble orthophosphate as phosphorus, total phosphate as phosphorus, nitrate + nitrite nitrogen as nitrogen, ammonia nitrogen, organic nitrogen as nitrogen, and Kjeldahl nitrogen as nitrogen. Metals measured in water samples included iron, arsenic, calcium, sodium and potassium. Total and fecal coliforms were determined by the Michigan Public Health Department. General chemistry included pH, alkalinity, hardness, chlorides, sulfates, turbidity and solids. Water samples were analyzed in the EPB, Lansing laboratory using methods approved by EPA 1974.

MACROINVERTEBRATES

Collections of stream macroinvertebrates were made twice during the assessment period at four stations: Station 5 on the North Branch of the Black River, Station 9 on the Macatawa, Station 11 on Indian Creek, and Station 19 on Gates Drain. Samples were collected quantitatively twice, utilizing multi-plate artificial substrate samplers after consecutive six week exposure periods. Artificial multi-plate samlers offer uniform substrates for macroinvertebrate colonization thus eliminating the affects of substrate variability. These newly established communities reflect the quality of water over the exposure period.

Samplers were fastened to natural, in-stream objects and suspended just above the substrate. When removed from the stream, the samplers were placed in labeled, wide mouth quart glass jars, preserved with 95 percent ethyl alcohol and returned to the EPB, biological laboratory in Lansing. Samplers were disassembled and the contents washed in a U.S. Standard No. 30 mesh screen.

Qualitative collections were taken each time artificial substrates were retrieved. Samples were collected with long handled triangular dip nets and by hand picking. Collected detritus and debris were placed in a sieve bucket with a U.S. Standard No. 30 mesh screen bottom. Collecting at each location was based on the law of diminishing returns (i.e., it was continued until most of the available species had been collected). Collecting was completed when approximately five minutes of additional work failed to yield any new species. About two-thirds of a quart of the collected material was retained after sorting and sieving. All samples were labeled, preserved with formalin at the station site and transported back to the EPB biological laboratory in Lansing.

SEDIMENT CHEMISTRY

Sediments from three stations: Blue Creek, Rabbit River and Black River were sampled for heavy metals, and pesticides and phthalate analysis. Samples of loose, organic substrate were collected on October 2, 1975 and placed in labeled glass jars. Analysis was completed by the EPB Lansing laboratory. Heavy metals determined were arsenic, copper, mercury, cadmium, total chromium, zinc, nickel, tin, antimony and selenium. Pesticides and phthalates included parathion, guthion, dieldrin, chlordane, dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), dichlordiphenyltrichloroethane (o,p-DDT), dichlorodiphenyltrichloroethane (p,p-DDT), hexachlorobenzene (HCB) and hexachlorobutyldiene (HCBD), heptachlor, atrazine, 2,4-dichlorophenoxy acetic acid (2,4-D ester only), 2,4,5-trichlorophenoxy acetic acid (2,4,5-T), polychlorinated biphenyl (PCB) as 1242, 1254, 1260 and the phthalates, diethylhexyl (DEHP) and dibutyl (DBP).

DISCUSSION

STATION 1 - BLUE CREEK

Blue Creek, located in Berrien County, is a tributary to the Paw Paw River with a basin area of 25.7 square miles, the smallest basin studied. The station is located 0.8 miles from the stream mouth. The stream bottom was composed primarily of sand. Surrounding sand soils facilitate rapid drainage. Land use in the watershed upstream from Station 1 is dominated by fruit orchards (30 percent) and pasture (30 percent). Data collected at this station include water and sediment chemistry parameters.

Surface water nutrient levels were slightly elevated. Blue Creek had a 1975 yearly nitrate-nitrite nitrogen mean of 0.845 mg/1, and a range of 0.58 to 1.41 mg/1. The mitrate-nitrite peak was found during the fall high flow period, as occurs in some Michigan streams (Grant 1975). The total phosphorus level was relatively low and ranged from 0.03 to 0.065 mg/1, with the higher level encountered in the spring high flow period.

Suspended solids ranged from 6 to 32 mg/1 with a mean of 15 mg/1. Total dissolved solids were low throughout the study ranging from 224 to 286 mg/1.

Iron levels ranged from 280 to 1,250 µg/1, with the elevated concentration found during spring high flow.

Total coliform bacteria counts ranged from 60 - 1,900,000 cts/100 ml with the maximum value found in July. The fecal coliforms ranged from 40 - 2,700 with a peak also taken in July. The coliform bacterial densities encountered after the July sampling were minimal.

Sediment concentrations of arsenic (20 mg/kg) and zinc (116 mg/kg) were elevated. Hesse and Evans (1972) reported mean background levels (+2 std. dev.) in Michigan streams as 2.0 mg/kg for arsenic, and 53 mg/kg for zinc. A mean level of 12.5 mg/kg arsenic was reported for samples from industrial or municipal complexes. The arsenic level found at Station 1 exceeded both levels previously found for background and below municipal and industrial complexes. Zinc exceeded the mean background level. Since these metals have been used in pesticides and herbicides for spraying fruit crops, accumulations of such compounds suggests runoff from orchards at the probable source. Copper, chromium,

nickel and antimony were present in the sediments at low levels. Sediment metal concentrations in Blue Creek were the highest encountered in this study, exceeding levels in both the Rabbit and Macatawa Rivers.

Sediments were analyzed for 20 synthetic hydrocarbons and with the exception of a very low level of DDE (57 µg/kg), none exceeded the analytical sensitivity limits.

This study indicates Blue Creek was slightly enriched from elevated levels of nitrate with the suspected source as seepage and runoff from the surrounding agricultural land within the watershed. A mean nitrogen/phosphorus (N/P) ratio of 41.3 indicates Blue Creek was phosphorus limited. High levels of arsenic and zinc in stream sediments were the only other parameters indicating lowered water quality and also reflect the influence of watershed runoff. Blue Creek ranked 9th in water quality among the 19 stations in this study.

STATION 2 - SOUTH BRANCH PAW PAW RIVER

The South Branch of the Paw Paw River is situated in Van Buren County and drains into the Paw Paw River Basin. This river basin has an area of 101.3 square miles. Land cover above this station was primarily cultivated crops (21 percent) and pasture (32 percent). Twelve livestock operations were also present in this watershed. Silty substrate at Station 2 indicated slow flow, with an average discharge of 196 cfs. Only surface water chemistry data was collected.

The nutrient N and P levels were low, tending to increase with increased flow, and reaching maximum levels during high flow conditions in the springtime. Nitrate-nitrite nitrogen ranged from 0.44 to 1.41 mg/l with a mean of 0.792 mg/l. Total phosphorus ranged from 0.016 to 0.09 mg/l with a mean of 0.036 mg/l. Aquatic macrophytes such as duckweed and Potamogeton crispus were observed in abundance during the July sampling period.

Suspended solids had a yearly mean of 8.0 mg/l, with the maximum level of 16.0 mg/l, representing relatively low concentrations. This low solid level indicates minimal erosion or land runoff.

Maximum total and fecal coliform counts occurred in July with 14,000 and 2,300 cts/100 ml, respectively. Numerous feedlots within the watershed may have contributed to this increased count. Total and

fecal coliform counts were substantially low throughout the entire remaining sampling period.

Previous water quality data from the main branch of the Paw Paw River from 1967 to 1975 is presented in Appendix V. This data indicates slightly higher total phosphorus levels, ranging from 0.01 to 1.16 mg/1, as compared to the 0.016 to 0.09 mg/1 of the present data. Other previous nutrient values were similar to values found in the present study.

Station 2 had very slightly enriched nutrient conditions as indicated by the abundance of plants. The levels of solids and major ions were low, and indicated no water quality problems. A mean N/P ratio of 42.1 reflects a surplus of nitrogen, with phosphorus as the limiting nutrient. This station appeared to be a higher water quality station overall, and ranked 6th among all stations.

STATION 3-SOUTH BRANCH BLACK RIVER

The South Branch Black River is located in Van Buren County and drains into the Black River (South Haven). It has a watershed of 89.8 square miles. United States Geological Survey (USGS) has a gauging station (number 04102700) located here and the mean annual discharge at this point is 230 cfs. Land use above the sampling site was primarily pasture (41 percent), cultivated crops (17 percent), and broadleaf forest (17 percent). Surface water chemistry was the only data obtained from this station.

Nutrient levels were low. Nitrate-nitrite levels ranged from 0.28 to 0.61 mg/1 with a mean of 0.451 mg/1. The highest level of 0.61 mg/1 was measured during spring high-flow, a relatively low level. Total phosphorus had a mean of 0.077 mg/1 with a range of 0.04 to 0.172 mg/1. These levels were lowest during the medium flow (September-October) and highest during the high flow in July and February-March. A heavy rain storm in July eliminated low flow conditions, and accounts for elevated concentrations of most chemical parameters.

Total dissolved and suspended solid concentrations were low throughout the sampling period with a mean of 255 mg/1 and 15 mg/1, respectively. Suspended solids increased during high flow conditions only twice, the remaining measurements were below 9 mg/1.

The major cation composition shows a slight shift from the percentage of calcium ions to sodium ions when compared with other stations.

Total iron reached a peak of 1,900 µg/l in July with a yearly mean of 830 µg/l. Elevated iron concentrations may stimulate bacterial growth under the appropriate pH conditions. Two elevated iron levels were associated with high flows and increased turbidity, suggesting increased particulate iron.

The fecal coliform counts ranged from 60-450 cts/100 ml, with the maximum counts occurred in July. Total coliforms ranged from 1,100 - 18,000 cts/100 ml. High fecal counts are associated with increased total coliform densities. Three of the eight fecal coliform samples were elevated, and may indicate a specific source of contamination. High fecal coliform densities are usually a result of warm-blooded animal contamination.

The South Branch of the Black River presently has low levels of nutrients and solids. The N/P ratio of 12.32 was the lowest ratio among all stations studied, and is a level expected in natural conditions. Water color was fairly clear, and no aquatic macrophytes were observed at this station. Only parameters with elevated levels were iron and fecal coliforms. The frequency of these elevated parameters may indicate a possible sanitary or livestock waste source. This station ranked 12th among all stations studied.

STATION 4 - MIDDLE BRANCH BLACK RIVER

The Middle Branch of the Black River is tributary to the Black River and is located in Allegan County and has a basin of 86.1 square miles. This station had a good gravel substrate, generally clear water, and an average discharge of 158 cfs. Salmon were observed at this station in November. Land cover consists of broadleaf forest (29 percent), brush (24 percent), and pasture (15 percent). Surface water chemistry was the only data collected at this station.

Nitrate-nitrite levels ranged from 0.24 - 0.40 mg/l, with a yearly mean of 0.311 mg/l. The peak was measured during spring high flow conditions. Total phosphorus levels ranged from 0.024 - 0.123 mg/l, with a mean of 0.045 mg/l. Two elevated peaks (July and Spring) were observed for most nutrients. This occurred because a heavy July rain simulated the high flow conditions associated with spring high flow.

Suspended solids were extremely low with a range of 1.0 - 29.0 mg/1 and a mean of 8.0 mg/1. The high value was also determined in July. Total dissolved solids levels were highly variable throughout the year with a range of 202.0 - 334.0 mg/1.

Chlorides and sodium at Station 4 were elevated with highest levels in September and November. Concentrations were the maximum levels reported among all 19 stations. Sodium represented 40 percent of major cations; while other streams averaged between 10 to 15 percent sodium. Chlorides composed 38 percent of the major anions, while other stations averaged about 10 percent. These concentrations may indicate an unnatural NaCl loading source.

Fecal coliforms ranged from 10 - 2,200 cts/100 ml with a mean of 583 cts/100 ml. Fecal counts were high in one July and September sample, counts were low during the remainder of the sampling period. Total coliform densities ranged from 400 - 2,200 cts/100 ml, with the peak occurring in September.

Station 4 had low nutrient and suspended solid levels. N/P ratio of 16.1 is a normal ratio expected under natural conditions. Sodium and chloride concentrations were elevated and indicate a possible upstream source of wastes. The Middle Branch of the Black River ranked 8th among the rivers sampled in this study.

STATION 5-NORTH BRANCH BLACK RIVER

Station 5 is located on the North Branch of the Black River in the southwestern corner of Allegan County within the Black River (South Haven) Basin. The 69.3 square miles of watershed is primarily rural, with cultivated crops (26 percent) and broadleaf forest (27 percent). Bottom substrate was very silty, and representative of slow flow. The average annual stream discharge was 82 cfs.

Along with the general surface water chemistry, a biological assessment was also included in the evaluation of the North Branch of the Black River. A heavy rain storm in July accounted for elevated concentrations of most chemical parameters.

Nutrient values were highest during the first sampling run, July 1975. Nitrate-nitrite levels ranged from 0.88 to 1.35 mg/1 with a mean of 1.02 mg/1. Ammonia levels ranged from 0.018 to 0.166 mg/1; the only

high level occurred during fall high flow. Total phosphorus concentrations reached a peak of 0.110 mg/l during July, 1975 with a yearly mean of 0.048 mg/l.

Total dissolved solids concentration remained relatively stable throughout the year with values near 260 mg/l, while suspended solid levels were variable. The peak of 74 mg/l for suspended solids occurred in July, 1975 following a rain storm. This suggests some problem with erosion, as stream discharge increased to 80 cfs, 15 cfs above the average 65 cfs low discharge.

Comparing major anions, chlorides were elevated and represented 33 percent as opposed to the 10 percent average of all other stations. No increase in sodium was observed with elevated chlorides. Iron was also high during July with 1,500 µg/l.

Total coliforms were extremely low throughout the study period with counts ranging from 700 to 12,000 cts/100 ml. Fecal coliforms were found to be generally low with only one high count measured in July as values ranged from 10 - 2,600 cts/100 ml.

Biological investigation at Station 5 reflected slightly enriched water quality. Artificial substrate samplers had diversity calculations of 1.96 to 2.93 for two, six-week sampling periods. Mayflies composed 34 to 72 percent of the total number in these samples, while midges comprised 12 to 25 percent. Most species determined were facultative species which are tolerant of the warmer water, slow flow and nutrient enriched conditions found at Station 5.

Qualitative macroinvertebrate data indicated good water quality. An average of 26 species were collected in the two samplings. Diversity calculations were determined as 3.48 and 3.88 for the two collections. However, most of the diversity was due to the low numbers of evenly distributed facultative species. Organisms other than mayflies, caddisflies and midges, composed 60 to 63 percent of the animals collected, with a large composition of surface dependant organisms such as dragonfly larvae, and Corixidae (water boatmen). Also present were facultative species of clams, sow bugs, and scuds. These species are all indicative of slow flow, poor substrate and warm water. However, since the diversity is high, moderate water quality with slight enrichment was denoted.

The North Branch of the Black River was sampled after a heavy rainstorm in July, thereby masking normal summer low flow conditions. Erosion was a slight problem as reflected by fluctuating suspended solids and silty substrates. Biological assessment indicated good water quality with a high diversity of species tolerant of some nutrient enrichment. This stream ranked 14th among the stations sampled.

STATION 6-SWAN CREEK

Swan Creek is located in Allegan County, within the Allegan State Forest and tributary to the Kalamazoo River. The river basin occupies an area of 47.8 square miles and land is primarily covered with broad-leaf forest (32 percent) and brush (30 percent). Batrachospermum, an attached red algae, indicative of good water quality was observed in patches during the summer. Swan Creek at Station 6 was very shallow with an average discharge of 71.0 cfs. Sustrate was composed mainly of sand and gravel. Only water chemistry data was collected at this Station.

Nutrient levels in Swan Creek were always very low. The mean nitrate-nitrite level was 0.29 mg/1 with a range of 0.06 - 1.15 mg/1, while the total phosphorus had a mean of 0.04 mg/1 and a range of 0.027 - 0.071 mg/1. Both are low concentrations indicating good water quality.

Suspended solids were also found in low levels ranging from 2 to 9 mg/1. The metals determined in Swan Creek were the lowest concentrations found in all 19 stations.

Both total and fecal coliform levels throughout the year were low. Total coliforms ranged from 800 - 4,800 cts/100 ml with a mean of 1,857 cfs/100 ml and fecal coliforms ranged from 0 - 580 cts/100 ml with a mean of 157 cts/100 ml.

Swan Creek had low levels of all parameters measured and no indication of nutrient enrichment was apparent. The N/P ratio of 14.4 reflects a natural balance between nitrogen and phosphorus concentrations. This stations' water quality ranked first among all stations studied. Year round water conditions appeared stable within this watershed.

STATION 7-RABBIT RIVER

Station 7 is located on the Rabbit River in Allegan County with a basin area of 288.6 square miles. The Rabbit River eventually joins the Kalamazoo River. This river basin was the largest in the study. Surrounding land use was: cultivated crops (35 percent), pasture (27

percent), and broadleaf forest (23 percent). Also present on this watershed were 12 large livestock operations. Stream discharge fluctuated from 250 to 640 cfs during this study. Water was usually turbid, and the substrate was predominately clay. Water quality of the Rabbit River was determined by water chemistry and sediment chemistry parameters.

Nitrate-nitrite nitrogen levels ranged from 1.04 to 2.30 mg/l with a yearly mean of 1.38 mg/l. These elevated levels indicated excessive nitrogen input into this system. Total phosphorus levels ranged from 0.037 to 0.96 mg/l, and a mean of 0.187 mg/l, also indicating some enrichment.

Suspended solids ranged from 1.0 to 37.0 mg/l with a mean of 14 mg/l. Clay substrate may influence suspended solid concentrations.

Of the major anions and cations, chlorides (29 percent) and sodium (30 percent) were higher than most other stations investigated in this study. These ions were elevated during lower flow conditions.

Iron levels were elevated throughout the year with a range of 280 to 1,600 µg/l.

Total coliforms ranged from 1,400 to 23,000 cts/100 ml, with the maximum count recorded in July. Fecal coliform counts were low throughout the year ranging from 60 - 880 cts/100 ml.

Sediment chemistry for the Rabbit River suggests a slight elevation of arsenic and zinc concentrations. Michigan background levels for arsenic is 2 mg/kg, the level found at this station was 6 mg/kg. The zinc concentration of 64 mg/kg is higher than the background mean of 53 mg/kg (Hesse and Evans 1972). All other metals were at very low levels.

All concentrations of pesticides and organic contaminants in the sediments were below levels of detection.

Some erosion problems have been reported in this river basin. Elevated nitrate-nitrites, phosphorus, and salts (chlorides and sodium) indicate water quality degradation. The N/P ratio of 14.7 indicated a balance between nitrogen and phosphorus, even though they were both present in surplus quantities. Agricultural practices are probably responsible for these elevated levels. The Rabbit River ranked 16th in water quality among the stations within this study.

STATION 8-LITTLE RABBIT RIVER

Station 8 is located on the Little Rabbit River in Allegan County with a basin of 46.9 square miles and is part of the Kalamazoo River Basin. Land use was cultivated crops (39 percent) and pasture (33 percent) with four livestock operations in the area. Flow was variable with a range of discharge from 75 to 232 cfs. The substrate consisted primarily of sand. Water chemistry data was the only parameter used in determination of present water quality.

Nitrate-nitrite ranged from 1.09 - 1.60 mg/l, with a mean of 1.27 mg/l which indicates enrichment. Ammonia levels were elevated at spring high flow with 0.123 mg/l, with a yearly range of 0.023 to 0.123 mg/l. Total phosphorus ranged from 0.038 to 0.164 mg/l with a mean of 0.07 mg/l, a slightly elevated level.

Total dissolved solids ranged from 306 - 526 mg/l with a mean of 418 mg/l. This was the highest mean level found in the present study. Suspended solids ranged from 2 - 47 mg/l with a mean of 15 mg/l. Higher levels were associated with increases stream flows.

The major ion concentrations showed elevated chloride and sodium levels. Chloride represented 29 percent of the anions while the average among the other stations is 10 percent. Sodium was 30 percent of the cations, twice the average of other stations. These ions were elevated in throughout the year except during spring high flow, when a substantial decreased concentration occurred with dilution.

Total coliforms ranged from 2,000 - 28,000 cts/100 ml throughout the sampling periods with the high counts measured in July. Fecal coliforms ranged from 210 - 5,000 cts/100 ml, with high values also found in the July data.

The Little Rabbit River is nutrient enriched. Total solids, sodium, and chlorides were high. The N/P ratio at this station was 34.9, a value which indicates phosphorus as the limiting nutrient with a surplus of nitrogen. This station ranked 18th in water quality, a rank which suggests some water quality degradation as indicated by the above elevated parameters.

STATION 9 - MACATAWA

The Macatawa River (formerly the main branch of the Black River), situated in Ottawa County, has a 28 square mile basin and is tributary to Lake Macatawa at Holland. Agricultural land predominates in this watershed with (46 percent) pasture and (42 percent) cultivated crops. Sixteen animal waste systems are located within the basin.

Soil types in this area are varied ranging from clay to clay loam and silty clay glacial till to organic soils. Erosion varies with soil type and both erosion and sedimentation have been a problem in this area. USGS has a gauging station (number 04108800) at this site. Flow fluctuated with the discharge ranging from 40 - 460 cfs. The primary substrate was sand. Water chemistry, sediment chemistry and biological assessments were completed at Station 9.

This station had the highest nutrient levels of any station studied. Range for nitrate-nitrite was 1.57 - 4.3 mg/l with a yearly mean of 2.56 mg/l. Ammonia concentrations were highest at this station with a range of 0.015 - 0.76 mg/l, and a mean of 0.19 mg/l . Total phosphorus was also high with a range of 0.003 - 0.88 mg/l and a mean of 0.171 mg/l. The peak of 0.88 mg/l was found during the spring high flow.

Total dissolved solids were also elevated with a range of 228 - 414 mg/l and a mean of 360 mg/l. Suspended solids ranged from 5 - 24 mg/l with a yearly mean of 35 mg/l. Exceptionally high suspended solids encountered during spring high flow reflect substantial soil erosion.

Major ion comparison indicated increased salt concentrations. The sodium is 27 percent and chloride is 38 percent, whereas the norm for this study was 10 percent for both ions.

Arsenic levels in the water were only detectable during the spring high-flow sample. Iron concentrations were high throughout the year with a range of 360 to 4,700 µg/l, with a mean of 1,070 µg/l.

Coliform counts were generally low throughout the year. Total coliforms ranged from 100 to 30,000 cts/100 ml, with the high counts recorded in July. Fecal coliforms ranged from 10 to 1,350 cts/100 ml.

Sediment chemistry data showed no elevated concentration of heavy metals above background levels for Michigan. Pesticides and hydrocarbons did not exceed the limits of detectability. This station has the lowest sediment contaminant content of the three stations sampled.

Macroinvertebrate community structure from artificial substrate samplers in the Macatawa River had diversities of 2.46 to 3.24, indicative of fair to good water quality. While mayflies were the dominant organisms collected, only one or two species were represented. Stoneflies were absent, and caddisflies were present in low numbers. Pollution tolerant sowbugs were abundant.

Qualitative macroinvertebrate data at this station indicated fair to good water quality and substrate. Community diversity was 2.84 to 4.07 for the two sampling periods with mayflies, caddisflies, aquatic beetles and midges comprising the major portion of both the total number collected and the total number of species. The substrate was primarily sand, a poor macroinvertebrate habitat, but excellent habit occurred in a rocky riffle beneath the bridge.

Macatawa River exhibited excessive nutrient enrichment and the poorest water quality of the 19 stations studies, ranking 19. Substantial erosion is indicated by the exceptionally high suspended solid levels during high flow periods. Iron was found in high concentrations. N/P ratio was 30.5, a value which suggests a phosphorus limiting condition. Sediment chemistry results indicated no apparent toxic contaminant problems. Biological evaluations indicated fair to good water quality.

STATION 10- BATTLE CREEK RIVER

Battle Creek River is part of the Kalamazoo River drainage system and is located in Eaton County. The Battle Creek River basin is an area of 48.3 square miles, has poor drainage due to the surrounding organic or loam type soils. Flooding is a problem along the Battle Creek River, although it was noted only during the spring high flow period of this study. Land is used mainly for agriculture (pasture 47 percent and cultivated crops 28 percent) and there are more livestock operations at this watershed (20) than in other basins studied. Water chemistry parameters were used in the evaluation of present water quality.

An aquatic macrophyte, Carex sp. was observed in moderate densities in July. The substrate was gravel and the stream discharge was less than 10 cfs. Due to the inaccuracy of the prepared flow curve graph at this low cfs, the actual stream discharge was not recorded. Water was usually clear. Trout were observed at this station during fall sampling.

Nitrate-nitrite levels ranged from 0.06 to 3.0 mg/l, with a mean of 0.92 mg/l. Elevated values (1.56 mg/l) were determined during high flow periods, and have distorted the mean nitrate-nitrite level. The remaining values were low ($<$ 0.34 mg/l). Total phosphorus levels ranged from 0.041 - 0.113 mg/l with a mean of 0.066 mg/l.

Suspended solids were usually low with a mean of 10 mg/l and a range of 2 to 37 mg/l. Total dissolved solids were slightly elevated with a yearly mean of 353.2 mg/l and a range of 237 to 420 mg/l.

Major ions were not elevated at Station 10. The highest calcium concentrations occurred at this station with a yearly mean of 85 mg/l. This higher level of calcium represents only about a 5 percent increase when compared to the other stations. Iron concentrations ranged from 420 to 1,050 µg/l with a mean of 644 µg/l.

Total coliforms ranged from 1,100 to 33,000 cts/100 ml, with the larger counts measured during high flow periods. Fecal coliform counts were minimal throughout the entire sampling period with a range of 200 to 1,580 cts/100 ml.

High nutrient levels occurred in Battle Creek during high flow periods. N/P ratio is 21.8, suggesting a phosphorus limited environment. Twenty large livestock operations within the basin may contribute to this nutrient increase. Under low flow conditions, Battle Creek exhibits good water quality, and ranked 12th among all stations examined.

STATION 11- INDIAN CREEK

Station 11 is located on Indian Creek in Eaton County and has a 46.4 square mile river basin, tributary to the Kalamazoo River. Agriculture is a prominent land use in this area, with pasture (49 percent) and cultivated crops (22 percent).

Stream velocity was usually slow, however, a gravel substrate was present. Increased sedimentation was observed with high flow periods. Average stream discharge was 73 cfs. Indian Creek's present water quality was assessed by the analysis of water chemistry and by evaluation of the aquatic macroinvertebrate fauna.

Nitrogen levels indicated enrichment throughout the year, with increases during high flow periods. Nitrate-nitrite concentrations ranged from 0.1 to 5.4 mg/1 with a mean of 2.11 mg/1. Maximum level of 5.4 mg/1 was measured during fall high flow and was the highest concentration of nitrate-nitrite determined in the entire study. Ammonia levels ranged from 0.01 to 0.121 mg/1, with elevated levels during high flow periods. Phosphorus levels were slightly elevated with a range of 0.04 to 0.134 mg/1 and a mean of 0.071 mg/1.

Total dissolved solids levels were slightly elevated and ranged from 266 to 440 mg/1 with a mean of 350.5 mg/1. Suspended solids ranged from 3 to 30 mg/1, with a mean of 11 mg/1.

Major ions were found at slightly below expected levels. Iron concentrations ranged from 360 to 1,250 µg/1 throughout the sampling period. High values occurred during high flow periods.

Total coliform counts ranged from 1,500 to 30,000 cts/100 ml, with the high count found during low flow. Fecal coliforms counts were low ranging from 190 to 1,470 cts/100 ml for the entire sampling period.

A single set of artificial substrate macroinvertebrate data was available from Indian Creek, as the second set was lost in high water conditions. Diversity of these samples were high, 2.93 and 3.07, suggesting good water quality. Mayflies, scuds, and midges were the predominant forms present.

High water quality was also indicated in both qualitative collections with diversities of 3.97 and 4.27. Aquatic worms, scuds, and mayflies dominated the samples. Gravel and rubble substrate was present at this station and provided excellent habitat.

Indian Creek contained excessive nitrogen concentrations all year and exhibited further increases during seasonal high flow periods. The N/P ratio was 45.3, a value indicating surplus nitrogen in the system. Both nitrogen and phosphorus values were high in comparison to other streams. Biological criteria indicated good water quality. Indian Creek ranked 16th in water quality among the stations examined.

STATION 12 - RICE CREEK

Rice Creek is a second quality coldwater trout stream which passes through agricultural land (39 percent) pasture, (33 percent) cultivated crops and (15 percent) wetland marsh. The river basin has an area of 90.9 square miles and is part of the Kalamazoo River in Calhoun County.

Various aquatic macrophytes were abundant in July including Potamogeton natans, Vallisneria and duckweed. The water was fairly clear throughout the entire year. The average stream discharge was 59 cfs at this station.

Nutrient levels were low and not indicative of nutrient enrichment. Nitrate-nitrite levels ranged from 0.38 - 1.22 mg/l with a mean of 0.71 mg/l, with the spring high flow period carrying the maximum concentrations. Total phosphorus was found at very low levels and ranged from 0.023 - 0.048 mg/l with a mean of 0.029 mg/l.

Solids were also found in low concentrations. Suspended solids were as low as 2 mg/l and peaked at 26 mg/l in July during low flow. Usually the suspended solids reach their highest levels during high flow periods. Major ions did not exceed their expected background concentrations.

Coliforms (total and fecal) were low throughout the entire study. Total coliforms ranged from 1,300 to 12,100 cts/100 ml, and fecal coliforms ranged from 90 to 740 cts/100 ml.

None of the measured chemical parameters in Rice Creek indicated the presence of water quality problems. The N/P ratio was 49.2, suggesting phosphorus as the limiting nutrient. Nutrients, solids, coliforms and other parameters measured were found in low concentrations. Rice Creek ranking 7th, had good water quality throughout the study.

STATION 13 - NORTH BRANCH KALAMAZOO RIVER

The North Branch of the Kalamazoo River is situated in Jackson County where sandy loam and sandy clay loam soils are common. This river basin has an area of 88.2 square miles before it joins the Kalamazoo River. Flow was represented by an average discharge of 78 cfs. Surface water chemistry was the only data obtained from this station.

The second quality coldwater trout stream is located in agricultural land (33 percent) cultivated crops and (39 percent) pasture with 11 livestock operations.

Nitrate-nitrite levels ranged from 0.94 - 1.45 mg/1 with a mean of 1.15 mg/1. This concentration is higher than expected for background water quality. Total phosphorus and soluble phosphorus levels were both with ranges of 0.01 to 0.036 mg/1 and 0.003 to 0.02 mg/1, respectively.

Although high erosion rates exist in this area, solids were not found in excessive amounts in the Kalamazoo River. Suspended solids had a mean concentration of 11.0 mg/1, and a range of 3 to 32 mg/1.

Major ions were extremely low throughout the entire sampling period.

Fecal coliforms ranged from 50 to 2,100 cts/100 ml, with the high count measured in July. Total coliforms were low throughout the study ranging from 1,200 to 9,300 cts/100 ml.

The water quality in the North Branch of the Kalamazoo River was very good and ranked 4th. Nitrogen levels were elevated but were counter-balanced with extremely low phosphorus levels. The N/P ratio was 117.1, the highest ratio in this study.

STATION 14- WANADOGER CREEK

Station 14 is located on Wanadoger Creek, a tributary of the Kalamazoo River in Calhoun County. The upstream land usage is predominately pasture (51 percent), broadleaf forest (18 percent), and cultivated crops (18 percent). Wanadoger Creek has a basin of 52.0 square miles within rolling terrain. There are 14 livestock operations in this watershed.

A moderate amount of aquatic macrophytes were observed, including Saggitaria and duckweed during July, 1975. Stream velocity was slow with an average discharge of 105 cfs.

Water chemistry parameters were used to evaluate present water quality.

Nitrate-nitrite levels ranged from 0.39 to 2.40 mg/l, with a mean of 0.79 mg/l. The highest levels occurred during fall and spring high flows. Total phosphorus ranged from 0.029 to 0.062 mg/l with a mean of 0.042.

Suspended solids fluctuated throughout the year with the range of 2 to 36 mg/l, and a mean of 10.9 mg/l. The highest value was observed in July.

Major ions were low at this station. Iron levels ranged from 320 to 1,100 µg/l, with a peak present during high flow.

The present nitrate-nitrite data is higher on the average, than the previous monitoring data. Previous values for phosphorus are similar to the present data.

Total coliforms were low ranging from 1,000 to 17,600 cts/100 ml. Fecal coliforms were also low throughout the study ranging from 50 to 1,100 cts/100 ml.

Wanadoger Creek is a high quality warmwater stream, and ranked 10th in this study. High nitrogen levels occurred during high flow periods late in the year, after the growing season, or early spring. The N/P ratio is 30.6, suggesting phosphorus to be the limiting nutrient.

STATION 15-WABASCON CREEK

Wabascon Creek, a high quality warmwater stream, is located in Calhoun County and eventually drains into the Kalamazoo River. Land cover on the 50.9 square mile basin of the Wabascon Creek is dominated by agricultural usage pasture (35 percent), cultivated crops (19 percent), and forested areas (broadleaf forest, 15 percent).

Gravel substrate was present at this station and the average stream discharge was 117 cfs. The water was usually clear. There have been problems of erosion associated with Wabascon Creek. Increased turbidity has been observed with increased flow, however, this problem was not noticed during this investigation. Water chemistry data were used to assess present water quality at this station.

Nutrients at Station 15 were unusually low for the surrounding land cover which is 54 percent agriculture. Nitrate-nitrite nitrogen levels ranged from 0.12 - 0.72 mg/l with a mean of 0.29 gm/l. Maximum levels were found during spring high flow. This station had the lowest nitrate-nitrite levels among all stations studied. Total phosphorus levels were low ranging from 0.018 to 0.04 gm/l, with a mean of 0.028 mg/l. Soluble phosphorus levels remained relatively constant throughout the year with a mean of 0.014 mg/l, and a range from 0.009 to 0.018 mg/l.

Total dissolved solids remained fairly constant during all sampling periods, with the mean of 248 mg/l and a range from 205 to 273 mg/l. Suspended solids had a yearly mean of 11 mg/l, and ranged from 2 to 30 mg/l.

Chlorides in low concentration were found with a mean of 8.9 mg/l and a range from 6.3 - 11 mg/l. All other ions and metals were also found in low concentrations.

Coliform counts were extremely low. Total coliforms ranged from 700 to 8,400 cts/100 ml and fecal counts ranged from 10 to 460 cts/100 ml.

Wabascon Creek ranked 3rd in this study and had no apparent water quality problems. Nutrients, solids, major ions, and coliform counts were all low at Station 15. The N/P ratio of 22.6 suggests phosphorus to be the limiting nutrient. Wabascon Creek possessed good water quality.

STATION 16- AUGUSTA CREEK

Augusta Creek is a first quality coldwater trout stream located in the Kalamazoo River Basin in Kalamazoo County. Surrounding land usage ranges from pasture (36 percent) and cultivated crops (15 percent) to forested wetlands (15 percent) and swamp (9 percent). The basin of Augusta Creek is 36.4 square miles. This watershed contains eight animal waste systems. Stream substrate at this station was predominately gravel, an excellent macroinvertebrate habitat. Streambank shading was good. The USGS has a gauging station (number 04105700) at this location on Augusta Creek. Water chemistry data were the only parameters collected at this station.

Nutrient levels were low and suggested minimal enrichment even during high flow periods. Nitrate-nitrite nitrogen levels ranged from

0.72 to 1.22 mg/l with a mean of 0.94 mg/l. Higher level occurred during fall high flows and the lower level occurred during the spring high flow. Ammonia levels ranged from 0.005 to 0.045 mg/l, and were the lowest values among all streams studied. Total phosphorus levels ranged from 0.014 to 0.072 mg/l with a mean of 0.026 mg/l.

Suspended solids had a mean of 9.0 mg/l with a range of 1.0 to 35.0 mg/l. The maximum of 35 mg/l was measured during the July summer low flow.

Station 16 had the lowest yearly concentration of chlorides in relation to bicarbonate and sulfate among the 19 stations. All other major ions and metals were found in low concentrations.

Coliform counts were low throughout the sampling period. Total coliforms ranged from 100 to 8,100 cts/100 ml, and fecal counts ranged from < 10 to 190 cts/100 ml.

Results of surface water chemistry indicated good water quality in Augusta Creek and ranked 2nd in this study. There are no water quality problems associated with this station. The N/P ratio of 79.2 is explained by elevated nitrogen levels with very low phosphorus levels. This watershed appears to be very stable as indicated by the fairly constant flow, suspended solids and turbidity levels throughout the year.

STATION 17- BASE LINE CREEK

Base Line Creek, a second quality coldwater trout stream, located in Allegan County, is tributary to the Kalamazoo River Basin. 94.4 square miles of Base Line Creek basin consists largely of agricultural land pasture (42 percent) and cultivated crops (14 percent) and forest (broadleaf forest, 25 percent). There are 10 livestock operations in this watershed. Water chemistry data were used to evaluate present water quality of Base Line Creek.

The creek was shallow at Station 17. Substrate was primarily sand. The sampling location station was moved upstream in September because of bridge construction at the original site. After completion of the new bridge, a comparison sample was made by collecting water at both the old and the new sites. All parameters were almost the same at both stations. Flow was not computed since a flow curve graph was not available for the new site.

Nitrate-nitrite levels ranged from 0.09 to 0.52 mg/l with a mean of 0.34 mg/l. Total phosphorus ranged from 0.007 to 0.062 mg/l with a yearly mean of 0.031 mg/l. These concentrations were very low and suggested good year round water quality. The peak in nutrient concentrations occurred during the spring high flow when values were almost doubled compared to other sampling periods.

Total dissolved solids were relatively constant during this study with a yearly mean of 305.5 mg/l, and a range of 270 to 320 mg/l. Suspended solids were low, ranging from 2 to 31 mg/l with a mean of 10 mg/l. All major ions had low values.

Coliforms were also low during the entire year. Both total and fecal coliform counts were below the detection limit in the October sample. Total coliforms ranged from < 10 to 7,900, and fecals ranged from <10 to 290 cts/100 ml.

Base Line Creek contained low nutrients, solids, major ions, and bacterial counts throughout the entire sampling period. This station, ranked 5th in this study, had good water quality. The N/P ratio of 21.6 indicated a phosphorus limited environment.

STATION 18- GUN RIVER

Station 18 is located on the Gun River in Allegan County, a tributary of the Kalamazoo River. Agriculture is the dominant activity in the 128.2 square mile basin, with land cover represented by pasture (23 percent), cultivated crops (23 percent), and broadleaf forest (24 percent). There are 15 livestock operations on this watershed.

Gravel substrate was present with an average stream discharge of 221 cfs. Water chemistry was used to assess present water quality of the Gun River.

Nitrate-nitrite concentrations ranged from 0.41 to 1.14 mg/l with a yearly mean of 0.70 mg/l. Ammonia levels ranged from 0.047 to 0.24 mg/l, with a mean of 0.105 mg/l. This mean concentration was the second highest value of ammonia found in the entire study, exceeded only by the 0.19 mg/l in the Macatawa River. Elevated ammonia levels usually indicate recent organic pollution. Animal waste systems in the Gun River Basin are a possible source of high ammonia levels. Total phosphorus and soluble ortho-phosphate phosphorus ranged from 0.011 to 0.073 and 0.009 to 0.034 mg/l, respectively.

Total dissolved solids ranged from 289 to 326 mg/l with a mean of 313 mg/l. Suspended solids were elevated with a range of 5 to 41 mg/l, and a mean of 15 mg/l. This mean concentration was the second highest in the entire study.

Chloride concentrations were very low with a yearly mean of 8.8 mg/l. All other major ions did not indicate any apparent problem. Levels of iron were high with a range of 640 to 1,160 µg/l.

Total coliforms ranged from 1,000 to 62,000 cts/100 ml, with a maximum count during low flow. All other values were low. Fecal coliforms were low throughout the yearly sampling with a range from 60 to 850 cts/100 ml.

The Gun River is a second quality coldwater stream. Nitrogen levels, especially ammonia, were high during fall and spring high flow periods. The N/P ratio of 47.3 indicates phosphorus to be the limiting nutrient. Suspended solids and turbidity were slightly elevated throughout the study. An upstream low level erosional input to the Gun River is probable. This station ranked 11th in water quality for this study.

STATION 19 - GATES DRAIN

Gates Drain (West Branch of the Paw Paw River) is situated in Van Buren County with a 40.6 square mile river basin. Gates Drain is tributary to the Kalamazoo River. Agricultural land predominates in the Gates Drain watershed with (34 percent) pasture, (20 percent) cultivated crops, and (20 percent) vineyards. There are nine large livestock operations in this basin. The sandy soil (sand and gravel loams) within the cultivated fruit orchards have a higher erosion rate than general farming. However, these soils have a high permability and are well drained, providing constant groundwater recharge to the river, thereby reducing severe fluctuations in flow.

Along with water chemistry parameters, benthic macroinvertebrates were also assessed for the evaluation of Gates Drain water quality. Trout were observed at this station during summer sampling collections.

Nutrient levels were slightly elevated with extreme increases apparent during spring high flow conditions. Nitrate-nitrite levels were elevated throughout the year with the range of 0.78 to 1.42 mg/l,

and a mean of 1.02 mg/l. Ammonia levels increased from 0.024 to 0.21 mg/l from July to March, and the mean was 0.076 mg/l. Total phosphorus concentrations were low during this study with a mean of 0.058 mg/l. However, levels surged during spring high flow and peaked at 0.23 mg/l, of which 0.20 mg/l was soluble phosphorus. Total phosphorus ranged from 0.012 to 0.23 mg/l, and soluble phosphorus ranged from 0.009 to 0.20 mg/l, with a mean of 0.037 mg/l.

Total dissolved solids were slightly elevated throughout the study ranging from 276 to 396 mg/l. In most streams studied usually this parameter decreased after spring snow melt, however, the concentrations in Gates Drain remained elevated. Suspended solids ranged from 2 to 59 mg/l, with a mean of 14 mg/l.

Major ions were observed in expected concentrations. Iron levels were high with a range of 280 to 3,000 µg/l with a mean of 1,016 ug/l.

Total coliform counts ranged from 700 to 30,000 cts/100 ml, with high values recorded twice, once at low and once at mid flow. Fecal coliforms were low throughout the study period ranging from 100 to 900 cts/100 ml.

The biological investigation indicated moderate water quality. Diversity indices ranging from 2.28 to 3.30 were calculated from artificial substrate samplers. These values were the results of low numbers of organisms comprised of evenly distributed faculative species. Midges (33 to 59 percent) dominated the organisms collected. Mayflies (10 to 33 percent) were found in moderate numbers, while very few caddisflies (0 to 18 percent) were observed in samples collected.

Qualitative samples indicated low to moderate water quality. Diversity calculations were much lower than those of the artificial substrate samplers with values of 1.49 and 1.66 from the two sampling collections. These reduced values were due largely to the high numbers of scuds (83 percent) collected in contrast to the other species present. Station 19 had the lowest total number of species among the biological samples in this study. Hard substrate and lack of gravel or rubble may have inhibited the macroinvertebrate fauna.

Gates Drain, ranking 15th in this study, had slightly elevated nutrients which reached very high peaks during spring high flow conditions. The N/P ratio of 29.6 indicated phosphorus as the limiting nutrient, with a surplus of nitrogen.

The biological evaluation indicated only moderate water quality, at best. The low numbers of species and individuals in a benthic community dominated by facultative organisms suggested water quality degradation from a source other than nutrients. Further investigation should be conducted on this stream to determine the source of degradation.

SUMMARY

1. Between July 1975 and March 1976 this study was conducted to assess background water quality conditions at 19 stations in the Kalamazoo, Macatawa, Paw Paw, and Black River Basins. Parameters sampled were water chemistry, macroinvertebrates, and sediment chemistry.

WATER CHEMISTRY

2. All stations were sampled for 30 water chemistry parameters. Nutrients, suspended solids, chlorides, sodium and iron were determined to be the most significant parameters affecting water quality. Rankings of stations based on average concentrations of these parameters revealed three obvious water quality groupings: Blue Creek, S. Br. Paw Paw River, M. Br. Black River, Swan Creek, Rice Creek, N. Br. Kalamazoo River, Wanadoger Creek, Wabascon Creek, Augusta Creek, and Base Line Creek possessed good to high water quality; S. Br. Black River, N. Br. Black River, Rabbit River, Little Rabbit River, Battle Creek, Indian Creek, Gun River, and Gates Drain possessed moderate water quality and the Macatawa River exhibited degraded water quality.

3. Nitrate-nitrite as nitrogen was elevated beyond the expected background level at most stations. Ammonia as nitrogen was elevated at several stations. The N/P ratio's were generally high (> 21.6), a result of either excessive nitrogen levels or very low phosphorus concentrations. Only North Branch Black River (Station 3), Middle Branch Black River (Station 4), Swan Creek (Station 6), and the Rabbit River (Station 7) had a natural balance of nitrogen and phosphorus (12.3 to 16.1).

4. Chlorides had mean values ranging from 6.4 to 56 mg/l and mean sodium values ranged from 3.7 to 28 mg/l. Six stations, S. Br. Black River, M. Br. Black River, N. Br. Black River, Rabbit River, Little Rabbit River, and Macatawa River had consistantly high levels of these ions.

5. High levels of total iron were measured at most stations during periods of high flow.

6. Suspended solids were consistantly elevated at Gates Drain (Station 19), Little Rabbit River (Station 8), and the Gun River (Station 18). The Macatawa River (Station 9) had exceptionally high suspended solids during spring high flow. All other stations contained normal ranges of suspended solids.

7. The measured stream water quality did not have a detectable relationship to the major cover types of the watersheds.

MACROINVERTEBRATES

8. Three of the four rivers (N. Black, Indian Creek, Macatawa) sampled for macroinvertebrates appeared to have moderate to good water quality.

9. Gates Drain (Station 19), exhibited only moderate water quality, at best. Factors other than enrichment appeared to be inhibiting the macroinvertebrates community, however, the source(s) were not identified.

SEDIMENT CHEMISTRY

10. Three stations, Blue Creek, Rabbit River, and the Macatawa River were sampled for 10 heavy metals and 20 synthetic hydrocarbons.

11. Blue Creek possessed high arsenic and zinc concentrations, while the Rabbit River had elevated arsenic levels. These compounds may be residuals from past pesticide applications. Other metals were not significantly elevated. All sediment metals were consistantly highest in Blue Creek and lowest in the Macatawa River.

12. Nineteen of the 20 synthetic hydrocarbons were below the levels of analytical sensitivity. DDE was detected only in Blue Creek at 57 µg/kg, a low concentration.

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APPENDIX D

Selected References

SUPPORTING TECHNICAL PAPERS

No.	Title	Year
1	Analysis of Flood Plain Problems	1974
2	Analysis of Soil Erosion Problems	1974
3	Analysis of Wildlife Habitat	1975
4	Analysis of Wetlands	1976
5	Amphibians, Reptiles and Non-Game Birds and Mammals	1976
6	Inventory of Rare, Endangered, Scarce, and Other Herbaceous and Shrubby Plant Species	1976
7	Inventory of Prehistoric Sites	1976
8	Inventory of Historic Sites	1977

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U.S. Department of Agriculture and Richard W. Pippen, *Inventory of Rare, Endangered, Scarce, and Other Herbaceous and Shrubby Plant Species*, Technical Paper No. 6, Soil Conservation Service, East Lansing, Michigan, 1976, 18 p.

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